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ABSTRACT

This study is one of three designed to evaluate the effectiveness of the Unified Science and Mathematics for Elementary Schools (USMES) program. The school study is essentially a discussion of the link between program dissemination and student experience, a discussion of the form taken by USMES in schools and classrooms. Part one is a statistical study designed to answer such questions as: How much time does USMES take? How much instruction in basic skills is afforded? Under what conditions is instruction in basic skills maximized? What is the actual relationship between group work, hands-on activities, and problem-solving processes, and success of sessions? Part two is nonstatistical. It consists of a general examination of USMES at five schools. The general state of USMES is examined from both a pedagogical and a political point of view. (Author/BB)

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USMES School Study

Effects of School Strategies on USMES Utilization

SE 026 361

UNIFIED SCIENCES AND MATHEMATICS FOR ELEMENTARY SCHOOLS:
Mathematics and the Natural, Social, and Communication Sciences in Real Problem Solving

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Education Development Center
55 Chapel Street
Newton, Massachusetts 02160

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Carolyn Clinton Arbetter, Coordinator for Research Studies
Daniel S. Cooper, Senior Research Associate
George H. Stalker, Research Associate
Felicia DeMay Weitzel, Research Associate
Nancy Gardner Weiner, Administrative Assistant for Research Studies
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Phyllis Gentile helped me design a system for entering Class Session Report data onto computer files, and then actually entered the data from over one thousand reports rapidly and accurately.

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George H. Stalker
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DESCRIPTION OF THE STUDY

Introduction

The USMES Project conducted three studies in 1976-1977 to learn more about USMES resource teams, students, and school implementations. The USMES Team Study examined the USMES Resource Team Program and the factors that influenced how effective selective teams were in disseminating and implementing USMES. The USMES Student Study examined certain strategies for directly assessing the effects of USMES on students. Both the Team Study and the School Study are published under separate covers.

This volume is a report of the USMES School Study. The School Study is essentially a discussion of the link between program dissemination and student experience: a discussion of the form taken by USMES in schools and classrooms.

The plan of this study is to examine this link from two distinct points-of-view. Part I is a statistical investigations, designed to find general answers to centrally important questions concerning the use of USMES in the classroom. How much time does USMES take? How much instruction in basic skills is afforded? Under what conditions is instruction in basic skills maximized? What is the actual relationship between group work, hand-on activities, and problem-solving processes, on the one hand, and "success" of sessions, on the other? As a basis for this statistical examination, 1043 individual USMES sessions are analyzed.

Part II of this study is non-statistical. It consists of a broad general examination of USMES as practiced at each of five different schools (schools "A" through "D" of the student study, and one further school, designated school "E"). The general state of USMES at each school, from both a pedagogical and a political point of view, is assessed; then certain particularly significant issues are discussed "across" the five schools.

Ideally, the two main parts of this study are complements. The first seeks, as far as possible, to "smooth out" individual variations from teacher to teacher, school to school, and district to district. The unit of analysis is the USMES session; many teachers, working in schools, are studied, The second seeks rather to highlight individual variations. It is limited to five schools, and most of the emergent "conclusions" are hypotheses concerning the causes and effects of local variations among schools.

Both branches of the investigation are intended to be useful in improving local implementations of USMES. Part I is intended to be helpful for planning and documentation. Part II, it is hoped, will point to ways for making USMES as pleasant, rewarding, and effective as possible in a world of teachers, principals, classrooms, custodians, and concerned parents. It was necessary that two different populations be studied, chiefly because of limitations on time and funding. This fact is, of course, a disappointing one, since one "obvious" thing to do would be to incorporate statistical generalizations in our discussion of the schools of Part II. However, the need to employ already-available data for Part I made this impossible.

Part 1 Statistical Analysis

Statistical Analysis of USMES Class Sessions: Introduction

From approximately 1 January 1975 to 30 June 1976, USMES teachers in the field were encouraged to report on their classroom experiences by means of a standard form known as the Class Session Report. The purpose of this form was not, primarily, to amass statistical data. Rather, it was designed to afford USMES central office staff direct, informal "feedback" on the progress of USMES challenges in the field. Participating teachers were, for the most part, members of USMES resource teams. A small payment was provided to compensate respondents for the time they devoted to making these reports.

In all, 1043 valid reports were received. (A "valid" report, for these purposes, is any report belonging to a challenge of five or more separate sessions.) Fifty individual teachers were represented; these teachers submitted from 5 to 76 separate session reports. Seventy-two challenges, sequences of sessions progressing towards a solution to some real problem, were reported on. Members of 32 resource team components reported.

The following is a facsimile (front and back) of the form employed:

USMES Class Session report

Name: ______________________ Session Date: ______________________

Grade Level(s): ______________ School Principal: ______________________

School: ________________________________ ☐ Resource Team Member

Education Development Center, 55 Chapel St., Newton, MA 02160

USMES

1

USMES Unit *(please check one)*

___ Advertising
___ Bicycle Transportation
___ Classroom Design
___ Classroom Management
___ Consumer Research
___ Describing People
___ Designing for Human Proportions
___ Dice Design
___ Getting There
___ Growing Plants
___ Lunch Lines
___ Manufacturing
___ Mass Communications
___ Nature Trails
___ Orientation
___ Pedestrian Crossings
___ Play Area Design and Use
___ Protecting Property
___ School Supplies
___ School Zoo
___ Soft Drink
___ Traffic Flow
___ Ways to Learn/Teach
___ Weather Predictions

___ Independently developed unit, whose challenge is: ______________________

____

2

USMES Session Profile

(a) Length of USMES session: ___ AM/PM to ___ AM/PM.

(b) Number of students in class: _______, number actively involved: _______

(c) Other adults present (please give number of each):

____ student teachers ____ parents ____ resource teachers ____ other visitors:

____ aides ____ other teachers ____ curriculum specialists ______________

(d) Did the students work in small groups: ____ Yes, ___ No; on different tasks: ____ Yes, ____ No.
Please describe briefly the small group activities:

(e) Did the students participate in a class discussion: ____ Yes, ____ No;

on group tasks: ____ Yes, ____ No,
on how recent work relates to solving the challenge: ___ Yes, ____ No,
on future plans: ____ Yes, ____ No.

Please describe briefly the class discussion:

(over)

2

f) Did the students work on construction activities: ____ Yes, ____ No;

in the classroom (please give number of students): ________

in a separate Design Lab room (please give number of students): ________

Please describe briefly these construction activities:

3

Problem Solving Processes *(please check those which best describe this session's work by one or more groups of students)*

- ___ Identifying and defining the problem
- ___ Deciding on information and investigations needed
- ___ Determining what needs to be done first
- ___ Deciding on the best way to obtain the information that is needed
- ___ Carrying out the data collection procedures
- ___ Detecting flaws in the data gathering process or errors in the data itself
- ___ Organizing, analyzing, and interpreting the data
- ___ Suggesting possible solutions based on the data collected
- ___ Trying out various solutions and evaluating the results
- ___ Working to implement the solution decided on by the class

4

Basic Skills and Concepts *(please list those that were used in this session's work by at least one group of students)*

mathematics skills: ________________________________

language arts skills: ________________________________

science concepts: ________________________________

social studies concepts: ________________________________

5

How do you feel about this USMES session? *(please circle one number for each statement)*

	Strongly Agree	Agree	Disagree	Strongly Disagree
(a) The students seemed to be quite interested in their work.	1	2	3	4
(b) Overall, they made little progress on the challenge.	1	2	3	4
(c) Their investigations have been fairly superficial, so far.	1	2	3	4
(d) This session included time in which students used subject area skills and concepts.	1	2	3	4
(e) Many students had experiences that should help develop their interpersonal relations.	1	2	3	4
(f) I had to provide strong direction for this session's work.	1	2	3	4

6

Use of Time

If I had not used USMES today I would have used the time for ____ whole class work, ____ group work, ____ individual help, ____ seat work, ____ hands-on activities, ____ other: ________________________________

7

Comments *(please use extra sheet for your comments)*

The form shown above, though not designed to collect statistical information, is actually quite well adapted to doing so. Most of the process of adaptation is simply a matter of assigning missing values correctly. Specifically, Items (2d), (2e), and (2f) require well-considered logical algorithms to distinguish between negative and missing responses, and to detect anomalies resulting from the "hierarchized" question structure. For example, if a respondent to Item (2e) indicates that students did not participate in a class discussion but did discuss future plans, Item (2e) is rejected; if, however, a respondent does not indicate whether students participated in a class discussion, but does state that students discussed future plans, class discussion is constructed to have taken place.

Item (4), Basic Skills and Concepts, presents no real problem of tallying, since the mere presence or absence of an entry in each category is all that is recorded.

Item (5), "How Do You Feel About This USMES Session?" presented some problems because an early form of the Class Session Report (not shown) offered a different array of response options under Item (5). The early form offered four categories of response: strongly agree, uncertain, disagree, and strongly disagree; the later form (illustrated) offered four different categories: strongly agree, agree, disagree, and strongly disagree. About 100 reports use the early form, and the remainder use the later form. Our method has been to collapse all replies into two categories: agree and disagree. Replies of "uncertain" are not counted.

Despite its obvious shortcomings, Class Session Report data tells us a great deal about what really happens when USMES is used in the classroom. Findings will be presented in the following manner:

- In Section 4, descriptive statistics will be presented. That is, mean values, totals, and rudimentary frequency tabulations will be given. The purpose of this section is to familiarize the reader in a general way with the body of data being analyzed, and with the extent and scope of a "typical" USMES class session.
- In Section 5, we will explore the relationship between the USMES experience and basic skills instruction.
- In Section 6, we will investigate the effects of certain pragmatic variables (session length, class size, etc.) on the USMES experience, in an attempt to formulate some rough guidelines to aid the teacher in providing optimal USMES to his/her students.

Thus, the following sections appear in Part I, below:

Section 4, "USMES Usage in the classroom," page 10.
Section 5, "USMES and basic skills," page 24; summary, page 54.
Section 6, "Successful USMES," page 55; summary, page 70.

USMES USAGE IN THE CLASSROOM: A GENERAL DESCRIPTION

The tabulation of Class Session Reports as described in the previous session yields, first of all, a set of interesting descriptive statistics on USMES usage in the classroom. The tabulations recorded below should serve the reader both as a general introduction to the sort of data which may be secured by analyzing Class Session Report responses, and as an introduction to USMES activities.

Employment of USMES units

The following tabulation reports exactly which units were reported on by the 1043 respondents, and how often each unit was employed:

Frequency of employment for all units (n=1043)

Unit	*Sessions held*	*Percent of total*
Bicycle Transportation	24	2.3%
Classroom Design	78	7.5
Classroom Management	8	0.8
Consumer Research	162	15.5
Describing People	38	3.6
Independently Designed Units	32	3.1
Designing for Human Proportions	7	0.7
Dice Design	10	1.0
Getting There	15	1.4
Growing Plants	78	7.5
Lunch Lines	25	2.7
Manufacturing	164	15.7
Mass Communications	8	0.8
Nature Trails	39	3.7
Orientation	42	4.0
Play Area Design and Use	14	1.3
Protecting Property	37	3.5
School Supplies	16	1.5
School Zoo	110	10.5
Soft Drink	25	2.4
Ways to Learn/Teach	86	8.2
Weather Predictions	22	2.1
Totals	1043	100.0

The reader should understand that the numbers tabulated in the table above refer not to whole challenges conducted, but to individual class sessions held. Thus, for example, 110 classes were held, in an unspecified number of School Zoo challenges.

It is clear from the tabulation above that some units were used a great deal more than others. However, the reader is cautioned that most-used units were not always rated most successful by the teachers using them, and that much of the variation in frequency-of-employment above results from the fact that some units were made available by USMES central office much earlier than others.

Activities

A tabulation of the frequency of various activities carried out in the course of USMES sessions appears below:

Frequency of various activities in USMES sessions

Activity	*Number of sessions*	*Relative frequency of occurrence (Percent)*
Work in small groups	697	73.3 (n=951)
Work on different tasks	471	65.9 (n=715)
Discussion of group tasks	510	52.5 (n=972)
Discussion on how work relates to solving challenge	456	46.9 (n=972)
Discussion of future plans	520	53.5 (n=972)
Class discussion, all types	774	79.6 (n=972)
Construction Activities	441	42.3 (n=941)
Construction in the classroom	279	29.0 (n=1040)
Construction in Design Lab	169	16.2 (n=1043)

The reader will note, in the tabulation above, that the n varies appreciably from item to item. This is a reflection of the fact that not all questions on the form were answered by all respondents. Also, the following general observations can be made:

- work in small groups occurred very frequently (about 3/4 of the time)
- construction activities took place in about 1/2 of the sessions
- construction in the classroom was considerably more common than construction in design lab facilities, and accounted for over 60% of the total construction activities
- class discussion took place in about 80% of the sessions

USMES Classes

USMES classes varied widely, both in class size and in the number of students in each class directly involved in USMES activities. The tabulation below gives exact information:

Students in USMES classes

Item	*Maximum*	*Minimum*	*Mean*	*Median*
Size of Class	94	2	26.2	24.6
Number of students involved in USMES	81	2	23.3	22.9
Percent of class actively involved in USMES	100%	1.2%	89.5%	----

The above table is interesting chiefly for two reasons:

- it shows that very large and very small groups can be managed;
- it shows that, on the average, most (about 90%) of the students in any class where USMES is being taught are involved in the challenge.

The tabulations below indicate the grade levels of the USMES classes reported on, and the range of grade levels present at each session.

Grade level of USMES CLASSES (n=1026)

Level	*Sessions*	*Frequency (percent)*	*Cumulative frequency (percent)*
K	35	3.4%	3.4%
1	7	0.7	4.1
2	66	6.4	10.5
3	58	5.7	16.2
4	174	17.0	33.1
5	38	37.0	70.2
6	209	20.4	90.5
7	85	8.6	99.1
8	9	0.9	100.0
Total	1026	100.0	100.0

Range of grade levels in USMES classes (n=1038)

Levels in class	*Sessions*	*Frequency (percent)*	*Cumulative frequency (percent)*
1	816	78.6%	78.6%
2	201	19.4	98.0
3	21	2.0	100.0
Total	1038	100.0	100.0

The reader should note that most USMES classes were at grade levels 4 through 6, and most sessions included students of only one grade level. (For purposes of this study, "grade level" is tabulated at the mid-level of a three-level class, and the lower level of a two-level class.)

One common concern of newly trained USMES teachers is that they may be unable, unaided, to supervise USMES class sessions in which diverse activities and group tasks are being carried out. The following tabulation indicates how many USMES sessions were carried out with "visitors" (generally helpers rather than observers), and how many without:

USMES sessions with visitors present (n=1043)

Situation	*Sessions*	*Frequency (percent)*
No Visitors	850	81.5%
One or more visitors	193	18.5
Totals	1043	100.0

The reader can see that about 3/4 of the USMES sessions were carried out unassisted.

Scheduling

One of the most significant issues in introducing the USMES curriculum into a particular school environment is scheduling. Some issues are:

- how many sessions are needed for a given challenge?
- how frequently are sessions held?
- what is the length of most sessions?
- what other possible learning activities are given up to make time for USMES activities?

The following table gives statistics on total challenge length (that is, how many sessions make up a particular problem-solving "challenge").

*Total challenge length (n=1043 sessions)**

Total sessions in challenge	*Frequency* (percent)*	*Cumulative frequency* (percent)*
1-20 Sessions	63.5%	63.5%
21-40 Sessions	20.8	84.3
41-60 Sessions	15.7	100.0
Total	100.0	100.0

Minimum: 5 Sessions
Maximum: 60 Sessions
Mean* : 21.9 Sessions

*n is number of sessions (1043) rather than number of challenges (72). Presumably this gives a clearer picture of school commitment, in terms of time and effort, to challenges of various lengths.

The figures above are based on the 1043 sessions of the study, not the 72 challenges. For example, the table shows that 15.7% of all sessions conducted belong to challenges having between 41 and 60 sessions in them; it is not the case that 15.7% of the challenges contained between 41 and 60 sessions.

The frequency with which USMES sessions are held has long been a matter of deep concern to central staff members. The following tabulation shows how frequently USMES sessions were conducted among respondents.

*Frequency of sessions (n=891 sessions)**

Sessions per week	*Sessions*	*Frequency* (percent)*	*Cumulative frequency* (percent)*
1 Session/Week	70	7.9%	7.9%
1+ Session/Week	445	49.9	57.8
2+ Session/Week	273	30.6	88.4
3+ Session/Week	38	4.3	92.7
4+ Session/Week	65	7.3	100.0
Total	891	100.0	100.0

Mean= 2.0 sessions per week*

*n is number of sessions for which a mean number of sessions-per-week, computed on a challenge-wide basis, could be determined. Presumably such a tabulation gives the best possible representation of school commitment, in terms of time and effort, to USMES challenges scheduled at various intervals.)

In the table above, the first category is self explanatory; the second refers to cases where one or more, but less than two, sessions per week were held in the course of a challenge. The third refers to situations where two or more but less than three, challenges were held, etc. It is of some interest that general practices displayed here show a smaller frequency of USMES sessions than those recorded by respondents to the questionnaire for team-trained teachers (reported in the USMES Team Study). The discrepancy may result from the fact that some sessions (especially short sessions) were not reported on, and figures here were computed from the actual dates of classes for which reports were submitted.

Session length (in minutes), among the sessions reported on, is tabulated below.

*Session length (n=993)**

Length in minutes	*Sessions*	*Frequency (percent)*	*Cumulative frequency (percent)*
1-30 Minutes	127	12.8%	12.8%
31-60 Minutes	641	64.6	77.3
61-90 Minutes	123	12.4	89.7
91-120 Minutes	102	10.3	100.0
Totals	993	100.0	100.0

Mean: 61 minutes
Median: 50 minutes

*(Excludes a total of 50 sessions (4.8%) for which length could not be determined, or which, in a very few instances, exceeds 120 minutes.)

One issue, pertaining to the pedagogical "cost" of doing USMES, is where the necessary class time "comes from." The tabulation below lists six categories of activities replaced by USMES activities.

Time employed in USMES session

Item: "Time would have been used for..."	*Sessions for which particular item is cited*	*Percent of total sessions: (n=1043)*	*Percent of total citations (n=1630)*
Whole class work	444	42.6%	27.2%
Group work	324	31.1	19.9
Individual Help	365	35.0	22.4
Seat work	127	12.2	7.8
Hands-on activities	206	19.8	12.6
Other activities	164	15.7	10.1
Totals	1630		100.0

In the tabulation above, the first column shows the number of USMES sessions which took time away from the activity listed; the second column shows what percent of all sessions (that is, 1043 sessions) took time away from the particular activity, the third column shows the relative degree to which each activity, by comparison to the other five, was curtailed to make time for USMES sessions.

Employment of basic skills

One issue which of great interest to developers and implementers of USMES alike is the degree to which USMES participation fosters the development of basic skills. Much will be said on this subject later in this report. For the moment, it will suffice to tabulate the frequency with which, according to teachers' reports, USMES sessions afforded training in basic skills. The skills are tabulated within four major categories.

USMES sessions affording training in basic skills (n=1043)

Skill category	*Sessions employing skill*	*Percent of sessions employing skill*
Mathematics Skills	700	67.1%
Language Arts Skills	687	65.9
Science Concepts	501	48.0
Social Studies Concepts	650	62.3

The tabulation above is a reasonably conservative one, since, due to the "open-ended" format of the USMES Class Session Report form, respondents were obliged to specify which skills within each of the four categories were covered in each session.

Since it is one of the properties of USMES that it affords training in more than one basic skill category in the course of a single session, a further tabulation was made of the number of basic categories (out of the four shown above) exercised in the course of each USMES session:

Number of different skills categories exercised in USMES sessions (n=1043)*

Categories	*Sessions*	*Percent of sessions*	*Cumulative percent*
None	52	5.0%	5.0%
1 Category	195	18.7	23.7
2 Categories	284	27.2	50.9
3 Categories	273	26.2	77.1
4 Categories	239	22.9	100.0
Totals	1043	100.0	100.0

It is noteworthy that, in about 50% of the sessions, exercise in three or more different categories of basic skills (as classified above) was afforded.

Problem-solving Processes

The central issue of USMES, in the minds of its developers, is the degree to which classroom experience actually affords training in problem-solving. Accordingly, respondents were asked to report on each session with respect to the following ten processes:

DISCUSSION PROCESSES

- Identifying and defining the problem
- Deciding on information and investigations needed
- Determining what needs to be done first
- Deciding on the best way to obtain the information that is needed

INVESTIGATIVE PROCESSES

- Carrying out the data collection procedures
- Detecting flaws in the data gathering process for errors in the data itself
- Organizing, analyzing, and interpreting the data
- Suggesting possible solutions based on the data collected
- Trying out various solutions and evaluating the results

IMPLEMENTATION PROCESSES

- Working to implement the solution decided on by the class.

The employment of these processes is tabulated below, first in terms of the three major categories, and then in terms of the individual processes.

Employment of problem solving processes (n=1043)

Major process:	*Sessions in which process is employed*	*Percent of sample*
Investigative processes	633	60.7%
Discussion processes	631	60.5
Implementation processes	449	43.0
Any process	978	96.7

Problem solving processes employed (n=1043)

Process	*Number of sessions in which process was employed*	*Percent of sessions*
Identifying and defining the problem	387	37.1%
Deciding on information and investigations needed	360	34.5
Determining what needs to be done first	403	38.6
Deciding on the best way to obtain the information that is needed	353	33.8
Carrying out the data collection procedures	284	27.2
Detecting flaws in the data gathering process or errors in the data itself	213	20.4
Organizing, analyzing, and interpreting the data	281	26.9
Suggesting possible solutions based on the data collected	282	27.0
Trying out various solutions and evaluating the results	305	29.2
Working to implement the solution decided on by the class	449	43.0

Teacher assessment of the sessions

In order to secure a more general understanding of how successful each session had been, teachers were asked how they "felt" about each session, in terms of the following criteria:

- Student interest
- Progress on the challenge
- Depth or superficiality of investigation
- Use of subject area skills and concepts
- Experience in developing interpersonal relations
- Relative automomy and self-motivation of the class.

The following is a tabulation of teacher assessments of sessions according to each of these six criteria.

Teacher assessment of session by various criteria

Criterion	*Percent of session reports which were positive*
The students seemed to be quite interested in their work	97.5% (n=1012)
Overall, they made *substantial* progress on the challenge	91.2% (n=969)
The investigations have *not* been superficial	81.5% (n=922)
Students used subject area skills and concepts	83.5% (n=887)
Many students had experiences that should help develop their interpersonal relations	94.8% (n=905)
I *did not have to* provide strong direction	70.1% (n=965)

Overall teacher assessment of session by all criteria (n=961)

Number of positive responses (MAX = 6)*	*Sessions*	*Percent of sessions*	*Cumulative percent*
0	5	0.5%	0.5%
1	21	2.2	2.7
2	38	4.0	6.7
3	87	9.1	15.7
4	169	17.6	33.3
5	201	20.9	54.2
6	440	45.8	100.0
Totals	961	100.0	100.0

*See preceding table for separate listing of 6 criteria.

The reader can see from the tabulation above that two-thirds of the sessions were positively judged, by at least five out of six criteria.

USMES AND BASIC SKILLS

A particularly urgent concern in the minds of administrators, curriculum developers, and parents alike, is that basic skills and concepts in areas such as mathematics, language arts, science, and social studies be well taught, clearly reported, and accurately accounted for. From very early in the life of the USMES project, its developers have believed that processes of inquiry inherent in real problem-solving provide not only a desirable degree of student motivation, but also a context for effective and integrated presentation of basic skills and concepts.

Any attempt to confirm or deny, by objective means, this plausible but largely subjective conviction, must deal with sobering difficulties, both practical and theoretical. Among them are the following:

- The use of standardized tests, an obvious method for gaining information about student achievement in basic skills, presents methodological problems. First, the scores of all students, whether or not they receive USMES training, are constantly changing as the students grow. Thus, testing students "before and after" they receive the USMES "treatment" is not, by in large, a useful method. Second, there are sufficiently many variables (such as teacher, school, grades, "tracking", etc.) which have a dramatic effect on standardized test scores, that also directly affect the administration of the USMES curriculum, that even the grossest effects of basic skills instruction through USMES may be obscured.

- The use of classroom observers, another obvious method, presents practical problems. First, it is costly. Second, observers must deal with the different ways in which basic skills instruction is classified in different situations, and merge results from different schools. Further, there is some evidence (contained in this study) that the presence of a visitor somewhat depresses the level of basic skills instruction in an USMES classroom.

- Self-evaluation by teachers can be used; however, it may not give valid information, at least concerning the absolute number of skills treated in each session. That is, since the basic skills instruction entailed in real problem-solving challenges is dynamic and not deterministic, assessment of skills and concepts treated must be carried out retroactively for each session. Thus, individual teachers may be inclined to report all allusions, however peripheral, to basic skills and concepts, thus generating inflated statistics on the amount of basic skills instruction.

- When basic skills instruction takes place in an USMES session, it is difficult for anyone to assess whether this has happened "because of" or "in spite of" the distinctive features of USMES real problem-solving. It might be argued that any activity which places young

> children in a room with a skilled teacher will result, perforce, in some sort of basic instruction. Thus, it is difficult to compare the level of basic skills instruction in an USMES session with that which would have been provided had the distinctive elements of the USMES curriculum not been employed.

In view of these problems, the present study takes the following approach. Self-reporting is used; however, the USMES experience is separated into several aspects, and the frequency of skills instruction in the presence of each separately analyzed. Thus, the relative frequency of basic skills instruction in the presence of each aspect can be compared with the frequency of basic skills instruction in its absence. When this is done, self-reporting techniques can be employed with increased confidence, since any "inflation" of the absolute frequencies is automatically corrected for. Thus, with respect to each aspect, both a control group and a treatment group exist within our sample of USMES sessions. Naturally, the statistical results of this sort of investigation must not be misused. In particular, although tests of significance are used throughout, they should not be taken to demonstrate causal relationships between individual aspects and particular effects. It is part of the nature of the USMES experience that these individual aspects occur interdependently. The task of discriminating among causal relationships on an individual basis goes beyond the scope of the available data sample.

An interesting conceptual problem in the treatment of this data is the choice of unit-of-analysis. We have chosen, for various reasons, to employ individual class sessions (rather than, say, individual teachers, individual schools, particular USMES units, or completed whole challenges) as our unit-of-analysis. There can be no doubt that this method has its drawbacks. For example, it might be argued that our analysis really explores the effectiveness of varous "methods" of teaching USMES (methods incorporating particular aspects of USMES to varying degrees) and that to treat thirty sessions given by a particular teacher as sampling thirty different methods is to generate an unrealistically large $\underline{n}$ which leads to inflated results in tests of significance. It seems to us, however, that we are not in fact analyzing "methods" of teaching USMES; "methods" actually used by teachers for conducting USMES challenges are far more than mere ways of maximizing the apparent "success" of each individual session. Likewise, since self-reporting is used, systematic errors of assessment (rater error) would have far more serious distorting effects if any unit-of-analysis which lumped together reports made by the same individual (that is, any of the other possible units listed above) were used.

The problem of teacher bias (since teachers were being paid by the USMES project to report on their sessions) is interesting but probably less serious. Presumably there was a positive bias; this can hardly be debated. Presumably teachers would (consciously or otherwise) be inclined to report whatever they thought the USMES central staff wanted to hear. However, neither the reporting teachers in the field nor the central staff members administering the report system could have known that, months later, these open-ended reports would be subjected to statistical analysis for contrasts in observed success under different circumstances. At the time reports were gathered, all classes were regarded as receiving the "USMES treatment" to the same degree. Thus, though bias may have existed, it seems unlikely that it could have distorted the results we are particularly concerned about.

Responses to the Class Session Report allow us to break down the USMES experience either in terms of problem-solving processes, or in terms of classroom activities.

BROKEN DOWN BY PROBLEM-SOLVING PROCESSES:

(Discussion Processes)

- Identifying and defining the problem.
- Deciding on information and investigations needed.
- Determining what needs to be done first.
- Deciding on the best way to obtain the information that is needed.

(Investigation Processes)

- Carrying out the data collection procedures.
- Detecting flaws in the data gathering process for errors in the data itself.
- Organizing, analyzing, and interpreting the data.
- Suggesting possible solutions based on the data collected.
- Trying out various solutions and evaluating the results.

(Implementation Processes)

- Working to implement the solution decided on by the class.

BROKEN DOWN BY CLASSROOM ACTIVITIES:

- Student work in small groups.
- Student participation in class discussion.
- Student participation in class; a discussion on group tasks.
- Student participation in a class discussion of how recent work relates to solving the challenge.
- Student participation in a class discussion of future plans.
- Student work on construction activities.

USMES (Viewed as a Collection of Problem-Solving Processes) and its Relation to Basic Skills Instruction

The schemata given above provide for ten two-way partitionings of the Class Session Report data according to problem-solving processes. Training in basic skills and concepts, as reported in Section 4 of the Class Session Report, can be assessed according to each partitioning. One expects the results to be quite "conservative," since the format of Section 4 insists on a response in terms of specific skills and concepts, under the following headings:

- Mathematics Skills
- Language Arts Skills
- Science Concepts
- Social Studies Concepts

In tabulating, we have recorded only whether any mathematics skills instruction, language arts instruction, etc., takes place within a given session, and do not which skills, or how many skills are actually cited. This will, we hope, "smooth" differences in terminology among schools and teachers.

We recall from the previous section of this report that the overall frequency of instruction in each of the four skills categories is as follows:

USMES sessions affording training in basic skills (n=1043)

Skill category	*Sessions employing skill*	*Percent of sessions employing skill*
Mathematics Skills	700	67.1%
Language Arts Skills	687	65.9
Science Concepts	501	48.0
Social Studies Concepts	650	62.3

What follows is essentially a tabulation of the same statistic, except that it is reported separately for subgroups in which each of the ten problem-solving processes is, or is not, employed. Thus, for example, considering the problem-solving process "Identifying and defining the problem," we see that there are not merely four percentages given (one for each basic skill type), but eight: one for each basic skill type, both in the presence and in the absence of the process "identifying and defining the problem." Here is the tabulation:

Percent of Sessions Affording Exercise in Basic Skills and Concepts, with and without selected Problem-Solving Processes (n=1043)

Processes		*Percent of Sessions Exercising Mathematics Skills**	*Percent of Sessions Exercising Language Art Skills**	*Percent of Sessions Exercising Science Concepts**	*Percent of Sessions Exercising Social Studies Concepts**
Identifying and defining the problem	no	70.1%	62.9%	48.0%	58.4%
	yes	62.0	70.8	48.1	69.0
Deciding on information and investigations needed	no	68.2	61.2	47.0	60.0
	yes	65.0	74.7	50.0	66.7
Determining what needs to be done first	no	67.5	63.3	48.0	61.9
	yes	66.5	70.0	48.1	63.0
Deciding on the best way to obtain the information that is needed	no	66.4	64.4	48.3	60.7
	yes	68.6	68.8	47.6	65.4
Carrying out the data collection procedures	no	60.7	64.3	48.8	64.3
	yes	84.2	70.1	46.1	57.0
Detecting flaws in the data gathering process or errors in the data itself	no	63.4	64.2	47.8	62.4
	yes	81.7	72.3	48.8	62.0
Organizing, analyzing, and interpreting the data	no	61.4	64.3	47.8	63.3
	yes	82.6	70.1	48.8	59.8
Suggesting possible solutions based on the data collected	no	62.7	63.3	46.1	62.2
	yes	79.1	72.7	53.2	62.8
Trying out various solutions and evaluating the results	no	62.6	64.0	44.0	61.3
	yes	78.0	70.5	57.7	64.9
Working to implement the solution decided on by the class	no	60.8	65.8	45.3	65.2
	yes	75.5	65.9	51.7	58.6

*Column totals are not meaningful here, since the 10 processes given are not mutually exclusive.

The cells in the table may be read as follows. Let us consider the process "carrying out the data collection procedures," and its possible association with instruction in language arts skills. We observe that, in sessions where "carrying out the data collection procedures" did not take place, instruction in language arts skills occurred in 64.3% of the cases. Thus it would appear that, if we are viewing this process as "treatment," and language arts instruction as "outcome," the probability of language arts instruction arising is "increased" in the presence of the process. Two issues arise at once:

(1) How much is the probability of instruction in each of the four skill categories increased or decreased in the presence of each of the ten problem-solving processes?

(2) What is the probability in each case that this apparent increase or decrease shows up in our sample as the result of chance alone?

The first question is addressed in the table below. There, the per cent of increase or decrease is shown, for each of the 40 possible combinations of skill categories and problem-solving processes.

Percent Increase/Decrease in Number of Sessions Affording Exercise in Basic Skills and Concepts in the Presence of various Problem-Solving Processes (n=1043)

Process	*Mathematics Skills*	*Language Art Skills*	*Science Concepts*	*Social Studies Concepts*	*Mean % Change*
Discussion: Identifying and defining the problem	-11.6%	+12.5%	+ 0.1%	+18.2%	+ 4.8%
Deciding on information and investigations needed	- 4.7	+22.1	+ 6.4	+11.1	+ 8.7
Determining what needs to be done first	- 1.5	+10.6	+ 0.4	+ 1.9	+ 2.9
Deciding on the best way to obtain the information that is needed	+ 3.4	+ 7.0	- 1.4	+ 7.8	+ 4.2
Investigation: Carrying out the data collection procedures	+38.5	+ 9.0	- 5.4	-11.3	+ 7.7
Detecting flaws in the data gathering process or errors in the data itself	+28.9	+12.6	+ 2.1	- 0.7	+10.7
Organizing, analyzing, and interpreting the data	+34.4	+ 9.0	+ 2.1	- 5.5	+10.0
Suggesting possible solutions based on the data collected	+26.0	+14.8	+15.3	+ 1.0	+14.3
Trying out various solutions and evaluating the results	+24.6	+10.2	+31.0	+ 6.0	+18.0
Implementation: Working to implement the solution decided on by the class	+24.2	+ 0.2	+14.1	-10.1	+ 7.1

The general situation is now quite clear. All ten problem-solving processes seem, on the whole, to entail an increase in basic skills instruction. This may be seen from the fact that all entries under "Mean % Change" in the table above are positive. More specifically, instruction in Mathematics Skills is somewhat less likely in sessions where there is problem-solving discussion, but very much more likely in sessions where investigation or implementation processes take place. Language Arts instruction is facilitated to a moderate degree (about 100%) by each of the ten processes. Instruction in Science Concepts is similar, except that it is *very much* more likely in sessions where there is "trying out various solutions and evaluating the results," and a little *less* likely in sessions that involve "carrying out data collection procedures." Treatment of Social Studies Concepts is generally facilitated by discussion processes, and made less probable by investigation and implementation processes.

Some very rough summary figures may give the reader an overall sense of the magnitude of the effects shown. The mean change, for all 40 possible combinations, is an increase of 8.9%. That is, in the presence of any particular problem-solving process, the probability of exercise in each of the four basic skills categories is, on the average, greater by 8.9% than it would have been in the absence of that process. This might seem to be a small amount, but the reader should be aware that it applies separately to *each* problem-solving process, and to *each* category of basic skills. Indeed, for each session, the total effect of problem-solving processes on basic skills instruction might be quite large. 3.18 is the mean number of problem-solving processes employed in individual sessions, study-wide, suggesting something like a 31% mean increase (assuming independence, the factor is $1.089^{3.18} \approx 1.31$) in the frequency of instruction in *each* of the four basic skills categories. (The base level over which this improvement is presumed to take place is, of course, that engendered by the other features of USMES, such as construction activities, small group work, student autonomy, etc.) It would appear, then, that the magnitude of the relationship between problem-solving activity and basic skills instruction suggested by the present data is great.

However, if one wishes to examine the individual relationships tabulated above, it is important to assess the statistical significance of each increase/decrease. The tabulation which follows displays, in its cells, the significance levels of the relationships observed in all 40 cases. Positive and negative effects are distinguished where significant of at least the .05 level; direction of change is not shown (though small increases and decreases were actually observed) for non-significant results.

Significance of relationships between Basic Skills/ Concepts and Problem-Solving Processes

	Mathematics Skills	*Language Art Skills*	*Science Concepts*	*Social Studies Concepts*
Discussion: Identifying and defining the problem	--	++		+++
Deciding on information and investigations need		+++		+
Determining what needs to be done first		+		
Deciding on the best way to obtain the information that is needed				
Investigation: Carrying out the data collection procedures	+++			-
Detecting flaws in the data gathering process or errors in the data itself	+++	+		
Organizing, analyzing, and interpreting the data	+++			
Suggesting possible solutions based on the data collected	+++	++	+	
Trying out various solutions and evaluating the results	+++	+	+++	
Implementation: Working to implement the solution decided on by the class	+++		+	-

(Decrease)

Probability:*

Blank Cell	$p > .05$
-	$p < .05$
--	$p < .01$

(Increase)

Probability:*

Blank Cell	$p > .05$
+	$p < .05$
++	$p < .01$
+++	$p < .001$

*Probability value are based on 2 x 2 Chi-Square tests.

Significance levels apply to individual cells, and not to the table as a whole. It should be understood that the general significance of the effect is not undermined by the fact that many individual combinations fail to achieve significance at the .05 level. Also, since there are, in all, 40 cells, significance of individual effects at the .05 level should not be taken to have strong evidential value, since, where 40 tests have been carried out, one would expect results apparently significant at the .05 level to appear twice by chance alone.

One of the most striking features of the tabulation above is the strong effect (at the .001 level in every case) which investigative processes seem to have on mathematics instruction. The following table displays this effect in more detail.

Instruction in Mathematics Skills: Relationship to number of investigative problem solving processes carried out during a given session (n=1043)

Number of investigative processes (out of 5 possible)	*N*	*Sessions giving Instruction in Mathematics Skills*	*Percent*
0	410	208	50.7%
1	256	185	72.3
2	183	141	77.0
3	91	74	81.3
4	45	43	95.6
5	58	49	84.5
Total	1043	700	67.1

$F(5,1037) = 20.5090$ $p < .001$

It is also desirable to ascertain whether each of the ten problem-solving processes has, as is thought by those who have developed USMES, an integrating effect on the teaching of basic skills (that is, a tendency to provide simultaneous training in several skills). A measure that indicates integration, as well as total basic skill instruction, is the total number of skills categories, of the four we are considering, involved in each session. The study-wide mean for this statistic is 2.433.

Problem Solving Processes and Overall Integrative Basic Skills Exposure (n=1043)

Process	*Mean Number of Skill Categories treated in Sessions without Activity (Max = 4):*	*Mean Number of Skill Categories treated in Sessions with Activity (Max = 4):*	*F(1,1041)**	*P**
Discussion:				
Identifying and defining the problem	2.3948	2.4987	1.9078	.17
Deciding on information and investigations needed	2.3646	2.5639	6.8335	<.01
Determining what needs to be done first	2.4063	2.4764	0.8835	.35
Deciding on the best way to obtain the information that is needed	2.3971	2.5042	1.9471	.16
Investigation:				
Carrying out the data collection procedures	2.3808	2.5739	5.6208	<.05
Detecting flaws in the data gathering process or errors in the data itself	2.3783	2.6479	9.0060	<.01
Organizing, analyzing, and interpreting the data	2.3675	2.6121	8.9835	<.01
Suggesting possible solusions based on the data collected	2.3430	2.6773	16.9428	<.001
Trying out various solutions and evaluating the results	2.3184	2.7115	24.7413	<.001
Implementation:				
Working to implement the solution decided on by the class	2.3704	2.5167	3.9843	<.05

*Based on a one-way analysis of variance with presence of activity as independent variable, mean number of skill categories as dependent variable.

As the reader can see, all ten problem-solving processes appear to be positively related to basic skills instruction, since in all ten cases, the mean number of skill categories treated is greater in the presence than in the absent of the process. Furthermore, seven out of the 10 processes are individually significant at the .05 (and in some cases the .001) level. Thus, it would appear that the effect of each process on skills instruction in general is generally integrative and facilitative.

In an attempt to assess further the actual character of the effects involved, we have tabulated the ten processes cited above by three major process types: discussion, investigation, and implementation. Compilations following this framework, like those following the ten-way framework used above, show generally positive effects.

Problem-Solving Processes Types and Exercise in Basic Skills

Problem Solving Process Type		*Percent of sessions exercising Mathematics skills*	*Percent of sessions exercising Language Arts skills*	*Percent of sessions exercising Science concepts*	*Percent of sessions exercising Social Studies concepts*
Discussion Processes	no	71.6%	58.1%	44.7%	52.2%
	yes	64.2	71.0	50.2	68.9
Investigative Processes	no	50.7	59.5	39.8	60.2
	yes	77.7	70.0	53.4	63.7
Implementation Processes	no	60.8	65.8	45.3	65.2
	yes	75.5	65.9	51.7	58.6

Significance of Relationships between Problem-Solving Process Areas and Exercise in Basic Skills Areas (n=1043)

Process Type	*Mathematics Skills*	*Language Arts Skills*	*Science Concepts*	*Social Studies Concepts*
Any Discussion	-	+++		+++
Any Investigation	+++	+++	+++	
Any Implementation	+++		+	-

Probability* that difference is due to chance alone (negative correlation)

Blank Cell	$p > .05$
-	$p < .05$
--	$p < .01$
---	$p < .001$

Probability* that difference is due to chance alone (positive correlation)

Blank Cell	$p > .05$
+	$p < .05$
++	$p < .01$
+++	$p < .001$

*By One-Way analyses of variance, F(1,1041), with Use of Process as Independent Variable, Use of Skill as Dependent Variable.

These tabulations, analogous to the ones presented earlier, show the effects and significance levels which emerge when particular basic skills and types of real problem-solving processes are considered together. For example, those sessions in which no investigative processes took place afforded instruction in mathematic skill 50.7% of the time. Those in which one or more processes took place afforded instruction 77.7% of the time. This relationship is clearly a positive one, and (referring to the second of the two tables) is significant at the .001 level. It is interesting to observe that statistically significant negative effects do appear in two cells. This serves both as a caution (not all activities which may arise facilitate all categories of skills instruction), and an encouragement (clearly the positive results we do see are not there merely because some teachers fill our questionnaires more optimistically than others). In some instances, of course, teachers are simply unaware of the roles played by certain kinds of activities in particular formal disciplines. For example, "identifying and defining the problem" may entail the definition of variables, a mathematical operation which is not always recognized as such.

A tabulation showing overall basic skills activity, and employing this 3-way decomposition of problem-solving activities, follows.

Problem Solving Processes (Grouped) and Basic Skills (n=1043 Sessions)

Process	*Mean Number of skill types exercised in sessions without Process*	*Mean number of skill types exercised in sessions with Process*	*F(1,1041)**	*P**
Any Discussion	2.2646	2.5436	14.2586	<.001
Any Investigation	2.1042	2.6477	56.5401	<.001
Any Implementation	2.3704	2.5167	3.9843	<.05

*Based on one-way analysis of variance with use of activity as Independent Variable, Number of Skills Categories Used as Dependent Variable.

As the reader can see, all three classes of problem-solving activity appear to have positive effects, significant to at least the .05 level.

USMES (conceived in terms of classroom activities) and instruction in Basic Skills

As indicated earlier, it also is possible to partition the USMES experience in terms of classroom activity (rather than, as above, in terms of problem-solving processes). Perhaps the simplest way to assess the effect of each type of activity is to perform a T-test, comparing the mean number of basic skills categories dealt with per session in the presence, and in the absence of, each activity. The tabulations that follow show the effects of small group activities, students' work on different tasks, and construction activities, upon overall basic skills instruction.

Overall Instruction in Basic Skills, with and without Small Group Activities

			T-Test (Pooled Variance Estimate)		
Group	*N*	*Mean number of skill categories dealt with*	*T Value*	*DF*	*2-TAIL Probability*
Sessions without small group activities	257	2.1907	-4.63	948	<.001
Sessions with small group activities	693	2.5801			

Overall instruction in Basic Skills, in sessions with and without diversity of tasks

			T-Test (Pooled Variance Estimate)		
Group	*N*	*Mean number of skills categories dealt with*	*T Value*	*DF*	*2-TAIL Probability*
Sessions not involving student work on different tasks	244	2.2828	-4.68	713	<.001
Sessions involving student work on different tasks	471	2.7006			

Overall Instruction in Basic Skills Construction Activities

			T-Test (Pooled Variance Estimate)		
Group	*N*	*Mean number of skills categories dealt with*	*T Value*	*DF*	*2-TAIL Probability*
Sessions without construction activities	500	2.3080	-4.27	939	<.001
Sessions with construction activities	441	2.6281			

As the reader can see, each item shows a positive effect, and significance at the .001 level. Clearly these three characteristic USMES classroom activities--group work, task differentiation, and construction--do entail conditions which facilitate basic skills instruction. (The reader is cautioned, by the way, that these statistics do not justify the inference that there are three independent cause-and-effect relationships at the significance levels shown. It is obvious that the activities cited are not, even in principle, independent; still, the presence of each activity either is or entails a condition which facilitates basic skills instruction.)

The effect of class discussion appears to be positive as well, at the .05 level.

Overall Instruction in Basic Skills in Sessions with and without Class Discussion

			T-Test (Pooled Variance Estimate)		
Group	*N*	*Mean number of skills categories dealt with per session*	*T Value*	*DF*	*2-TAIL Probability*
Sessions with class discussion	700	2.5234	2.45	969	<.05
Sessions without class discussion	201	2.2985			

The effect shown above is positive but not especially strong. Fortunately, somewhat more exact information on the types of discussion carried out is available, and can provide clearer information on the nature of the positive effect.

Overall Instruction in Basic Skills; Relationship to Discussion of Group Tasks

			T-Test (Pooled Variance Estimate)		
Group	*N**	*Mean number of skills categories dealt with per session*	*T Value*	*DF*	*2-TAIL Probability*
Sessions with discussion of group tasks	501	2.7333	3.96	608	< .001
Sessions with discussion, but not of group tasks	100	2.2600			

Overall Instruction in Basic Skills; Relationship to Discussion on How Recent Work Relates to Solving the Challenge

			T-Test (Pooled Variance Estimate)		
Group	*N**	*Mean number of skills categories dealt with per session*	*T Value*	*DF*	*Probability*
Sessions with discussion of how recent work relates to solving the challenge	456	2.6996	3.08	569	< .01
Sessions with discussion, but not of how recent work relates to solving the challenge	115	2.3391			

Overall Instruction in Basic Skills; relationship to Discussion of future plans

Group	*N**	*Mean Number of skills categories dealt with per session*	*T-Test (Pooled Variance Estimate)* *T Value*	*DF*	*2-TAIL Probability*
Sessions with discussion of future plans	520	2.5846	0.10	595	.924
Sessions with discussion, but not of future plans	77	2.5714			

*Not all the 770 reports citing class discussion reported on the nature of the discussion. N, in these tables, refers to those who did so, for each issue.

Clearly, discussion of group tasks and discussion of how recent work relates to solving the current challenge both entail conditions favorable to instruction in basic skills; however, discussion of future plans does not; what we observe in that case is merely a small, non-significant, negative effect.

Thus, when one separately considers the USMES experience according to each of its characteristic classroom activities, one finds that each aspect of those enumerated on the Class Session Report form has or entails a positive influence on basic skills instruction.

"Success" in USMES versus *"Success" in Basic Skills Instruction*

Though it would appear that the elements of USMES, in themselves, strongly facilitate instruction in basic skills, they are sometimes "orchestrated," in the USMES experience, to serve superficially quite different ends. Thus, it might be argued, the elements of the USMES experience, if used to promote success implicit in USMES, may not be optimally applied toward "success" in basic skills instruction. For example, class autonomy and student interest, both conceived as important desiderata in the USMES experience, might conceivably be unimportant (or indeed, detrimental) in optimizing basic skills exposure.

It is with this concern in mind that six criteria for "success" listed on the Class Session Report form, of which only one is associated with basic skills exposure, are tabulated against each of the four basic skills and concepts.

Percent of Sessions Affording Exercise in Basic Skills and Concepts, broken down by Relative Success of Session in Terms of Cited USMES Criteria

Criterion		*Mathematics Skills*	*Language Arts Skills*	*Science Concepts*	*Social studies concepts*
Students' interest in work (n=1012)	successful	68.4%	67.2%	49.3%	63.8%
	unsuccessful	56.0	64.0	20.0	16.0
Progress on challenge (n=969)	successful	71.8	69.5	49.2	63.2
	unsuccessful	41.2	61.2	37.6	55.3
Depth of investigations (n=922)	successful	74.4	68.4	49.0	62.2
	unsuccessful	50.9	66.7	45.6	59.6
Time for subject area skills and concepts (n=887)	successful	76.4	73.8	52.1	64.0
	unsuccessful	45.2	45.2	28.8	47.9
Development of interpersonal relations (n=905)	successful	70.4	70.0	49.1	63.3
	unsuccessful	53.2	59.6	36.2	31.9
Self-motivation and direction (n=965)	successful	72.8	68.3	53.7	69.1
	unsuccessful	58.8	65.7	35.3	47.4

The results are striking. In all of the 24 comparisons made, a positive relationship is observed. This in itself indicates a strong overall relationship between reports of "success" defined in USMES terms, and reports of "success" in terms of basic skills exposure. Moreover, many of the individual items in the table above show statistical effects that are individually significant. The following tabulation gives a significance level for each of the 24 positive correlations in the table above.

Significance levels (by Chi-square test) for correlations relating criteria of successful USMES and exposure to Basic Skills

Criterion	*Mathematics Skills*	*Language Arts Skills*	*Science Concepts*	*Social Studies Concepts*
Students' interest in work	.2735	.9061	.0070	.0000
Progress on challenge	.0000	.1469	.0544	.1844
Depth of investigations	.0000	.7198	.4745	.5973
Time for subject area skills and concepts	(.0000)	(.0000)	(.0000)	(.0004)
Development of interpersonal relations	.0197	.1752	.1157	.0000
Self-motivation and direction	.0000	.4746	.0000	.0000

Even excluding the fourth row, which redundantly deals with basic skills exposure and should be ignored, fully 40% of the items show individual significance at the .01 level.

Conversely, the proportion of sessions rated as "successful" by at least five of the six criteria increases steadily along with the number of separate basic skills categories dealt with during the session.

Overall instruction in Basic Skills; relationship to overall success of USMES session by six selected criteria

Number of skills categories dealt with in session	*Number of Sessions*	*Number of sessions rated successful at least five criteria*	*Percent of sessions rated successful by at least 5 criteria*
0	44	11	25.0%
1	182	85	46.7
2	258	180	69.8
3	257	184	71.6
4	220	181	82.3

Thus, in general, it would appear that "success" by USMES criteria strongly entails "success" in basic skills exposure, and vice versa.

Optimal Conditions for Basic Skills Instruction Under USMES

For the user whose particular concern is instruction in basic skills, it may be helpful to consider some of the parameters of USMES teaching (session length, session frequency, class size, presence of aides, etc.) and their relationship to overall basic skills instruction. Only the most rudimentary comparisons have been made, but these should be enough to furnish the user with general guidelines.

Let us consider these issues one by one. The following tabulation shows overall basic skills instruction and session length.

Overall instruction in Basic Skills; relationship to session length

			T-Test (Pooled Variance Estimate)		
Group	*N*	*Mean number of skills categories dealt with per session*	*T Value*	*DF*	*2-TAIL Probability*
Sessions of greater than average length (61 minutes or more)	251	2.3825	-1.04	1017	.297
Sessions of less than average length (60 minutes or less)	768	2.4714			

No significant effect is disclosed.

The following tabulation explores the relationship between overall basic skills instruction during a session, and the total length of the USMES challenge to which the session belongs. As the reader can see, basic skills instruction took place more frequently in longer challenges. This does not merely mean that more basic skills instruction took place in the course of long challenges, but also that more instruction, per session, took place.

Overall instruction in Basic Skills; relationship to Length of Challenge

			T-Test (Pooled Variance Estimate)		
Group	*N*	*Mean number of skills categories dealt with per session*	*T Value*	*DF*	*2-TAIL Probability*
Sessions in challenges which used 16 or more segments of class time*	537	2.5456	3.20	1041	<.001
Sessions which used challenges fewer than 16 segments of class time*	506	2.3142			

*For all sessions, study-wide, the mean length of the challenge-in-progress is 16 sessions.

One item of concern to users is the effectiveness of basic skills instruction in USMES classes incorporating two or more grade levels. The following tabulation is directed to this issue.

Overall instruction in Basic Skills; relationship to number of grade levels in USMES class

			T-Test (Pooled Variance Estimate)		
Group	*N*	*Mean number of skills categories dealt with per session*	*T Value*	*DF*	*2-TAIL Probability*
Sessions with classes incorporating more than one grade level	222	2.6982	3.92	1036	< .001
Sessions with classes whose students are at a single grade level	816	2.3529			

The level of basic skills exposure does not seem to be reduced by the incorporation of more than one grade level in a single USMES class. In fact, an increase in overall basic skills exposure, significant to the .001 level, is observed.

Total class size is an issue of some concern to USMES teachers. The following tabulation shows the relationship of overall basic skills instruction to class size.

Overall instruction in Basic Skills; relationship to class size

Group	*N*	*Mean number of skills categories dealt with per session*	*T-Test (Pooled Variance Estimate)* *T Value*	*DF*	*2-TAIL Probability*
Sessions with class of 26 or more*	490	2.3429	-2.48	1012	<.05
Sessions with class of 25 or fewer*	524	2.5248			

*Mean class size, studywide, is 26.

It is interesting that basic skills instruction seems relatively more effective in smaller classes, and that this finding is significant at the .05 level. As we will see in the following section, success ratings by the six USMES criteria discussed above tend to favor larger rather than smaller classes--and this result, too, is significant at the .05 level. Thus, in this one instance, optimal USMES and optimal basic skills instruction are favored by different conditions.

There is some concern among USMES teachers and developers about the percentage of a given class directly involved with USMES at any one time. This issue is addressed in the following tabulation.

Overall instruction in Basic Skills; relationship to proportion of total class involved in USMES

			T-Test (Pooled Variance Estimate)		
Group	*N*	*Mean number of skills categories dealt with per session*	*T Value*	*DF*	*2-TAIL Probability*
Sessions with 89.5% of class or more directly involved*	849	2.4335	0.08	1028	.933
Sessions with less than 89.5% of class directly involved	181	2.454			

*Mean percentage of class directly involved in USMES for all Sessions reported on is 89.5%

As the reader can see, this variable has no significant effect on overall basic skills instruction, at least by the particular partioning we have chosen.

Another issue of frequent concern has been the capability of individual teachers to conduct the complicated and diverse activities of an USMES session without help. In an attempt to find out whether this has any effect on basic skills instruction, we have partitioned the sessions according to the absence or presence of visitors/aides. The result is displayed in the following tabulation.

Overall instruction in Basic Skills; relationship to the presence of Visitors/Aides

			T-Test (Pooled Variance Estimate)		
Group	*N*	*Mean number of skills categories dealt with per session*	*T Value*	*DF*	*2-TAIL Probability*
Sessions with one or more visitors/ aides present	193	2.3368	-1.27	1041	.206
Sessions with no visitors/ aides present	850	2.4553			

No significant effect is observed.

Finally, for the reader with a special interest in particular basic skills items, we tabulate exactly what percentage of sessions in each unit provided exposure in each of the four basic skills categories.

Percent of Sessions Affording Exercise in Basic Skills, by Unit

Unit	*Number of Sessions*	*Mathematics Skills*	*Language Arts Skills*	*Science Concepts*	*Social Studies Concepts*
Bicycle Transportation	(n=24)	75.0%	87.5%	87.5%	100.0%
Classroom Design	(n=78	82.1	75.6	71.8	87.2
Classroom Management	(n=8)	75.0	62.5	25.0	25.0
Consumer Research	(n=162)	66.7	63.6	38.9	63.6
Describing People	(n=38)	60.5	78.9	31.6	92.1
Independently developed unit	(n=32)	37.5	62.5	31.3	81.3
Designing for Human Proportions	(n=7)	14.3	28.6	42.9	71.4
Dice Design	(n=10)	100.0	80.0	20.0	0.0
Getting There	(n=15)	66.7	0.0	13.3	53.3
Growing Plants	(n=78)	65.4	79.5	76.9	43.6
Lunch Lines	(n=28)	50.0	89.3	50.0	85.7
Manufacturing	(n=164)	78.0	53.7	45.7	64.0
Mass Communications	(n=8)	37.5	50.0	0.0	12.5
Nature Trails	(n=39)	79.5	25.6	12.8	2.6
Orientation	(n=42)	45.2	78.6	19.0	85.7
Play Area Design and Use	(n=14)	57.1	100.0	35.7	85.7
Protecting Property	(n=37)	45.1	62.2	43.2	43.2
School Supplies	(n=16)	81.3	68.8	43.8	0.0
School Zoo	(n=110)	60.0	50.0	63.6	73.6
Soft Drink	(n=25)	88.0	96.0	60.0	60.0
Ways to Learn/ Teach	(n=86)	65.1	81.4	45.3	57.0
Weather Prediction	(n=22)	90.9	90.9	72.7	22.7
All Units	(n=1043)	67.1%	65.9%	48.0%	62.3%

The reader who wishes to use this table for purposes of unit selection is cautioned to consider not only the percentage figures shown, but the number of session reports (given in parentheses in the leftmost column) upon which our figures have been based. Where only a few sessions have been reported on, the reader should place relatively little faith in the percentage figures generated. On the other hand, where many sessions have been reported on, it is likely that, since many teachers and many different sets of circumstances have been involved, the figures given are quite general and quite reliable.

Summary

- Real problem-solving processes in USMES do seem to increase the amount of basic skills instruction reported. Specifically, for the 10 processes studied, the use of each accompanies an increase in the overall level of basic skills instructions across four categories of skills (page 31, Mean % Change).

- When all 10 processes studied are individually paired with each of four basic skills categories: Math Skills, Language Arts Skills, Science Concepts, and Social Studies Concepts of the combinations, 43% show individually significant positive effects at at least the .05 level and 8% show negative effects (page 33, table).

- Instruction in Mathematics skills is especially strongly entailed in "Investigative" problem-solving processes. Each of the five processes studied shows a positive effect on Math skills instruction which is significant to the .001 level (pages 33 and 34).

- An increase in integration of basic skills instruction (measured by the mean number of different skills categories treated per session) is entailed by all 10 processes studied. In seven out of the ten, this increase is individually significant at at least the .05 level.

- The following classroom activities used in USMES also entail an increase in basic skills integration and overall basic skills instruction, significant at at least the .05 level: Small group activities ($p < .001$), Diversity of tasks ($p < .001$), Construction Activities ($p < .001$), Class Discussion ($p < .05$).

- To determine whether a "successful" session, as judged by USMES criteria, is also a "successful" session in terms of basic skills instruction, each of six criteria for "USMES success" was viewed along with each of the four "basic skills" areas. In all of the 24 resulting cases, the relationship was positive. In half of these instances, the positive effect was individually significant at the .01 level. (Page 43).

- The level of basic skills instruction in a particular session is positively related to the following: number of sessions in challenge, number of grade levels in class ($p < .001$ in both instances).

- The level of basic skills instruction in a particular session is negatively related to class size ($p < .05$).

- The level of basic skills instruction in a particular session is not significantly related (at the .05 level) to the following: session length, percentage of class involved in the challenge, presence of visitors/aides.

SUCCESSFUL USMES

USMES teachers and their principals may wish to know under just what circumstances (class size, length of session, etc.) an USMES experience which is by some standard "optimal" can take place. While such "optimal" values (e.g., 47.3 minutes, 21.6 students, etc.) could in principle be ascertained, a very large data sample would be required, since perimeters for different grade levels and different units would probably differ greatly. Certainly, deriving "optimal" values of this sort is far beyond the scope of presently available data, which is based on the conduct of only 72 challenges.

However, the scope of the present sample does permit us to derive certain basic recommendations, (generally expressed in terms of "long" versus "short" sessions, or "large" versus "small" classes). The reader is cautioned that here, as in the previous section, our tests of statistical significance are not to be taken as seeking evidence that particular variables are actually causes of the effects discussed. Rather, they are to be understood as pointing to circumstances which either cause, or on the whole accompany circumstances which cause, the effects cited. This, of course, is consistent with the needs of a teacher or principal who wishes to improve, rather than anlyze, local USMES teaching.

The Number of Sessions in a Challenge

The mean number of sessions per challenge in this study is 16. In the following tabulation our sample is divided into two parts, sessions from longer than average challenges, and sessions from shorter than average challenges, and the two parts are examined for the "overall success" rating of the sessions they encompass. (Criteria for success here are the same six criteria employed in the previous section, Section 5 above):

- Student interest
- Progress on the challenge
- Depth or superficiality of investigation
- Use of subject area skills and concepts
- Experience in developing interpersonal relations
- Relative automomy and self-motivation of the class.

			T-Test (Pooled Variance Estimate)		
Group	*N*	*Mean number of criteria according to which session was favorably assessed (Maximum possible=6)*	*T Value*	*DF*	*2-TAIL Probability*
Sessions in long challenges (challenge length=16 sessions or more)	537	5.1844	2.89	1013.57	<.01
Sessions in short challenges (challenge length=15 seconds or less)	506	4.9209			

The reader can see from the tabulation and test of significance that sessions of greater than average length tend to be "more successful" (by the particular criteria used) than shorter challenges. The reader should be cautioned, however, that this effect cannot be generalized to some principle such as "the longer the better." Indeed, when a coarse partitioning is used, and the whole range of session length is considered, no evidence is found to support such a generalization.

Overall Success of USMES Session and total challenge length (n=961 sessions)

	Count *Row %* *Col %* *Total%*	*Number of Classes in entire challenge:*			*Row Total*
		1-20	*21-40*	*41-60*	
Sessions rated successful according to 4 or fewer criteria (max = 6)		210 65.6% 34.0% 21.9%	66 20.6% 31.7% 6.9%	44 13.8% 32.4% 4.6%	320 33.3%
Sessions rated successful according to 5 or more criteria (max = 6)		407 63.5% 66.0% 42.4%	142 22.2% 68.3% 14.8%	92 14.4% 67.6% 9.6%	641 66.7%
	Column Total	617 64.2%	208 21.6%	136 14.2%	961 100.0%

Chi=square = 0.43587, with 2 degrees of freedom;
Significance = 0.8042

USMES Session Length

For the entire sample, the mean length of USMES sessions was found to be 61 minutes. If the sample is partitioned by this value, the results are as follows.

			T-Test (Separate Variance Estimate)		
Groups	*N*	*Mean number of criteria according to which session was favorably assessed (Maximum possible=6)*	*T Value*	*DF*	*2-TAIL Probability*
Sessions over an hour long	251	5.3426	3.67	467.47	< .001
Sessions an hour or less in length	768	4.9727			

As the reader can see, sessions more than an hour in length appear to be more "successful" than shorter sessions; this result is significant at the .001 level. A generalizing principle, "the longer the better," would seem to be roughly borne out, as the following cross-tabulation shows:

Crosstabulation of overall success of USMES session and length of session (n=914 sessions)

Count Row % Col %	*Session Length* 1-30 minutes	 31-60 minutes	 61-90 minutes	 91-120 minutes	Row Total
Sessions rated successful according to 4 or fewer criteria (max = 6)	52 17.8% 44.1%	201 65.7% 33.8%	40 13.1% 33.6%	13 4.2% 15.9%	306 33.5%
Sessions rated successful according to 5 or more criteria (max = 6)	66 10.9% 55.9%	394 64.8% 66.2%	79 13.0% 66.4%	69 11.3% 84.1%	608 66.5%
Column Total	118 12.9%	595 65.1%	119 13.0%	82 9.0%	914 100.0%

Chi Square = 17.40435, with 3 Degrees of Freedom;
Significance = 0.0006

Above, the proportion of sessions rated as successful by at least five out of six criteria rises from a minimum of 55.9%, in sessions 30 minutes in length or shorter, to a maximum of 84.1% in sessions 91 through 120 minutes long.

The reader is cautioned, however, that when individual criteria are considered, the results are far from "smooth."

Criterion	Number of sessions evaluated	*Percent of sessions given a positive evaluation in terms of criterion:* 1-30 minute sessions	31-60 minute sessions	61-90 minute sessions	90-120 minute sessions	Overall
The students seemed to be quite interested in their work	966	95.2%	97.3%	99.2%	99.0%	97.4%
Overall, they made *good* progress on the challenge	923	80.0	91.5	96.6	94.9	91.1
Their investigations have been fairly *comprehensive,* so far	877	63.6	81.7	82.9	95.8	81.2
This session included time in which students used subject area skills and concepts	843	78.4	85.4	78.4	89.3	84.0
Many students had experiences that should help develop their interpersonal relations	862	87.0	96.1	94.0	97.5	94.9
I *did not have to* strong direction for this session's work	922	62.9	71.4	59.6	86.7	70.5

Thus, an attempt to discriminate too finely among session lengths, searching for an optimal effect, is probably unjustified.

Small Group Work

As the following tabulation shows, sessions in which students worked in small groups tended to be more successful than sessions where this was not the case.

Groups	*N*	*Mean number of criteria according to which session was favorably assessed (Maximum possible=6)*	*T-Test (Pooled Variance Estimate)* *T Value*	*DF*	*2-TAIL Probability*
Sessions in which students did not work in small groups	257	4.5564	-6.14	378.45	<.001
Sessions in which students worked in small groups	693	5.2843			

Of course, this does not mean that all sessions should include work in small groups; naturally, challenges require some sessions which do not entail small group work.

Student work on different tasks

In general, sessions in which students work on different tasks seem to have been most successful.

Groups	*N*	*Mean number of criteria according to which session was favorably assessed (Maximum possible=6)*	*T-Test (Separate Variance Estimate)* *T Value*	*DF*	*2-TAIL Probability*
Sessions in which students did not work on different tasks	244	4.9590	-3.28	433.16	<.01
Sessions in which students worked on different tasks	471	5.3270			

Class Discussion

In general, sessions which incorporated class discussion do not appear to have been significantly different in overall "success" from those which did not.

			T-Test (Pooled Variance Estimate)		
Groups	*Sessions*	*Mean number of criteria according to which session was favorably assessed (Maximum possible=6)*	*T Value*	*DF*	*2-TAIL Probability*
Sessions without class discussions	201	5.1841	1.29	407.37	.20
Sessions with class discussions	770	5.0571			

However, when the nature of the discussions was submitted to a finer breakdown, the following results appeared.

Groups	*Sessions*	*Mean number of criteria according to which session was favorably assessed (Maximum possible=6)*	*T-Test (Pooled Variance Estimate)* *T Value*	*DF*	*2-TAIL Probability*
Sessions in which students held class discussion, but not on group tasks	100	4.7800	-3.11	608	< .01
Sessions in which students discussed group tasks	510	5.2725			

Groups	*Sessions*	*Mean number of criteria according to which session was favorably assessed (Maximum possible=6)*	*T-Test (Pooled Variance Estimate)* *T Value*	*DF*	*2-TAIL Probability*
Sessions in which students held class discussion, but not about how work relates to solving the challenge	115	4.8174	-3.58	569	<.001
Sessions in which students discussed how work relates to solving the challenge	456	5.3509			

			T-Test (Pooled Variance Estimate)		
Groups	*Sessions*	*Mean number of criteria according to which session was favorably assessed (Maximum possible=6)*	*T Value*	*DF*	*2-TAIL Probability*
Sessions in which students held class discussion, but not discussion of future plans	77	5.3506	1.50	595	.14
Sessions in which students held discussions of future plans	520	5.0786			

As the reader can see, sessions in which students discussed group tasks and sessions which students discussed how their work related to solving the challenge both were relatively "successful," whereas, sessions in which students held discussion of future plans appear to have been marginally less successful than those in which students held other sorts of discussions.

Construction activities

Sessions in which construction activities took place appear to have been more "successful" than others.

			T-Test (Separate Variance Estimate)		
Groups	*Sessions*	*Mean number of criteria according to which session was favorably assessed (Maximum possible=6)*	*T Value*	*DF*	*Probability*
Sessions without construction activities	500	4.7860	-6.72	929.50	< .001
Sessions with construction activities	441	5.3968			

Grade Level

The following is a tabulation of "success" by grade level.

Crosstabulation of overall success of session by grade level of class

	Grade Level									
Count *Col %*	*K*	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*Total*
Sessions rated successful according to 4 or fewer criteria (max=6)	7 25.0%	5 71.4%	19 31.1%	20 35.7%	64 39.0%	83 24.8%	87 43.5%	21 24.4%	6 66.7%	312 33.0%
Sessions rated successful according to 5 or more criteria (max=6)	21 75.0%	2 28.6%	42 68.9%	36 64.3%	100 61.0%	252 75.2%	113 56.5%	65 75.6%	3 33.3%	634 67.0%
Col. Totals:	28	7	61	56	164	335	200	86	9	946
Total Pct:	3.0%	0.7%	6.4%	5.9%	17.3%	35.4%	21.1%	9.1%	1.0%	100.0%

Though figures differ considerably from grade to grade, no generalization would seem to emerge. Grades 1 and 8 seem to show lower rates of success, but the number of sessions reported on are in both cases far fewer than for all other grade levels so these figures cannot be relied on. In any event, there seems to be no systematic effect of grade upon "success" in USMES

			T-Test (Pooled Variance Estimate)		
Groups	*Sessions*	*Mean number of criteria according to which session was favorably assessed (Maximum possible=6)*	*T Value*	*DF*	*2-TAIL Probability*
Sessions with students at two or more grade levels	222	5.0540	-0.13	1036	.89
Sessions with students at one grade level	816	5.0600			

Class Size

Sessions with relatively large classes were more "successful" than those with relatively small classes.

			T-Test (Separate Variance Estimate)		
Groups	*Sessions*	*Mean number of criteria according to which session was favorably assessed (Maximum possible=6)*	*T Value*	*DF*	*2-TAIL Probability*
Sessions in classes with at least 25 students	490	5.1714	2.13	982.19	$<.05$
Sessions in classes with fewer than 25 students	524	4.9733			

It is interesting that this result, significant at the .05 level, is different from the result found when basic skills instruction is considered. By that criterion, smaller classes are found to be somewhat better.

Proportion of class directly involved in USMES activity

Study-wide, the mean proportion of any class directly engaged in USMES activity was .895. When the sample was partitioned into sessions where more than this proportion, and fewer than this proportion, were involved, the difference in overall "success" was not found to be significant.

			T-Test (Separate Variance Estimate)		
Groups	*Sessions*	*Mean number of criteria according to which session was favorably assessed (Maximum possible=6)*	*T Value*	*DF*	*2-TAIL Probability*
Sessions in which at least 89.5% of class is directly involved in USMES	849	5.0518	-0.58	290.98	.56
Sessions in which less than 89.5% is directly involved in USMES	181	5.1160			

Presence of aides/visitors

The presence of aides/visitors seem to have little or no effect on the overall "success" of USMES sessions.

Groups	Sessions	Mean number of criteria according to which session was favorably assessed (Maximum possible=6)	T-Test (Pooled Variance Estimate)		
			T Value	DF	2-TAIL Probability
Sessions with visitors present	193	5.0518	-.05	1041	.96
Sessions without visitors present	850	5.0576			

This is of some interest to the new USMES teacher, since one anxiety felt by many is that they will, unaided, be unable to supervise a full range of USMES activities in the classroom. The tentative finding of this study, that aides are not necessary, is borne out also by the following.

Crosstabulation of sessions including construction activities and Sessions where one or more visitors/ aides were present (n = 941)

Count *Row %* *Col %*	*Sessions with no visitors/ aides*	*Sessions with one or more visitors/ aides*	*Row Total*
Sessions with no construction activity	403 80.6% 52.0	97 19.4% 58.4	500 53.1%
Sessions with some construction activity	372 84.4% 48.0	69 15.6% 41.6	441 46.9%
Column Total	775 82.4%	116 17.6%	941 100.0%

Chi-Square = 2.02155, with 1 degree of freedom; significance = 0.1551

From this tabulation, it would appear that even the use of construction activities, a very beneficial but potentially "tricky" matter for new USMES teachers, does not require visitors or aides.

Range of grades in USMES sessions

The number of grade levels present in a given USMES session seems to have no significant effect on the overall success of the session.

Summary

Available data from the Class Session Reports suggests the following:

- Challenges of 16 sessions or longer are more successful than shorter challenges.
- Sessions at least an hour long are more successful than shorter sessions, and the general principle "the longer the better" is roughly true.
- Sessions with small group activities are more successful than those without.
- Sessions where students work on different tasks are more successful than those where this does not take place.
- Certain types of class discussion are positively related to session success.
- Sessions with construction activities are more successful than those without.
- No general rule can be adduced which relates session success to grade level.
- The range of grade levels in a particular USMES class does not seem to affect success.
- Classes with at least 25 students seem somewhat more successful than those with fewer.
- The proportion of students engaged in any one session challenge seems to have little effect on success.
- The presence of visitors/aides does not seem to affect success.

Part 2 Interviews

CASE STUDY OF FIVE USMES SCHOOLS: INTRODUCTION

In Spring 1977, USMES teachers, non-USMES teachers, and principals at five USMES schools were interviewed. Although a number of issues proved to be of recurring major importance and a checklist of questions was used (see Appendix), no fixed format was used in conducting the interviews. A single interviewer, the USMES project director, conducted all discussions.

The five schools have been designated "A" through "E." Schools "A" through "D" are the same as the schools so designated in the USMES student study. School "E" is an addition, and serves to increase the total range of material available for our examination and interpretation. The schools to be studied were selected not because they were all successful (some have serious problems) but because on the whole they display an interesting and, we hope, representative range of political and pedagogical developments to USMES, both positive and negative.

Section 8, below, is expository. It sets out a brief description of each of the five schools, commencing with a description of the school itself, and proceeding to characterize its USMES activity in each case.

Section 9, which follows, is interpretive. It consists of a discussion of major issues which, we believe, underlie the circumstances detailed in Section 8. The emphasis throughout Section 9 is on generating explanatory hypotheses and, at aimes, direct recommendations which may be useful to teachers and administrators in the field.

Section 10 is speculative. It consists of several discussions which "go beyond" the data, proposing mechanisms and hypotheses which attempt to explain the investigative findings reported in Section 8. The material in Section 10 is tentative and exploratory, but will, we hope, be thought-provoking and practically useful.

Sections following are:

Section 8, "The five schools," page 73.
Section 9, "Interpretive issues," page 84.
Section 10, "Speculative Issues," page 100.

CASE STUDIES

THE FIVE SCHOOLS

School "A"

School "A," located in the mid-central part of the United States, has an enrollment of about 300 elementary-level wtudents. The school is located in a small city (population about 50,000), and the racial/ethnic composition of its students is about 99% white, 1% Asian and Black. The neighborhood contains a university; most nearby residential structures are "expensive" houses. School "A" is located in an affluent district which may be expected to have strong interests in securing academic advancement for its students.

Recently, USMES challenges have been carried out in mass communications, playground safety and improvement, advertising, designing for human proportions, manufacturing, using free time, and other areas.

The school does not place much emphasis on providing Design Lab facilities. A portable cart is available, but opinion is divided as to how useful it is. The use of teachers' aides in connection with USMES is not a significant feature of the school's USMES policies. One second-grade teacher commented on the difficulties of conducting USMES activities with only part of a class, since this entailed planning something to do with the rest of the students during USMES time.

Generally, science and social studies time is used for USMES activity. Sessions are 45-50 minutes long, and scheduled about four times a week. There is some feeling that these periods are "a little short," and that students may be frustrated by the need to stop USMES activity after only a few minutes. Other scheduling needs are the cause of this limitation.

No specific procedures exist for teachers to report USMES activity to principal or district, but general reporting procedures within the district have recently become quite stringent, and are expected to become more stringent still. One teacher reports being "swamped" by accountability procedures.

District interest in basic skills instruction and recent district directives are seen as contributing to a climate with is rather uncongenial to the practice of USMES. This is in some respects an anomalous situation, since the overt philosophical position of the district seems to favor real problem-solving--a real problem-solving correlates very well with stated district objectives, and USMES is even specifically mentioned in the district science objectives. In fact, there is a deeply felt division, both among administrators and among parents, on the subject of innovative instruction; but in general it is the earlier climate which was favorable to USMES and is reflected in the district science objectives, and the later climate which places an emphasis on basic skills instruction in a traditional mode. Fortunately for the USMES program at School A, however, the principal newly installed to "bring order" to the school seems quite sympathetic to USMES.

Within School A, apparently, the use of USMES is not divisive. The school custodian is not offended by the students' construction activities, and relations between USMES and non-USMES teachers are described as "good." In fact, several "non-USMES teachers" are said to have used USMES units.

Relations with parents are strained and in some ways unsatisfactory. In the immediate past, parents have been critical of School A because of a lack of "specific" science instruction, and because they wish to see evidence of skills advancement (such as homework) and do not regard real problem-solving as a matter of high priority. The negative attitude of at least some parents was shown by parental criticism of an "amateurish" play given and entirely produced by students in connection with an USMES project. The fact that, apparently, some parents did not realize the play had been produced entirely by students is a symptom of the poor communication problem may account for some of the parental skepticism observed.

Many parents seem to be unfamiliar with the goals of USMES (some parents try to solve problems for their children!), but when consulted by and surveyed by one teacher, only ten percent of the parents responding thought USMES a "waste of time."

Clearly, however, more than communication problems are involved. There are in the district two mutually antagonistic parent groups which meet separately and espouse different policies. Further, although some parents are charmed by their children's enthusiasm for real problem solving, others are not, and wish to be assured in advance what basic skills instruction will be provided by a given USMES unit.

The effect of USMES on School A students is described in quite positive terms. It was reported that "kids' inquiry skills are more defined," and that they "zero in on a topic" faster. It was observed that "socialization goes on between kids" in the course of an USMES challenge, that "slower kids come forward" and that students with learning problems can, in the course of challenges, become "real leaders." Apparently, standardized test scores have not been affected, positively or negatively, where USMES has been employed instead of some other curriculum material.

It is interesting that in the view of School A teachers, slower students benefit most from USMES, whereas the principal suspects that USMES is "particularly suited for gifted students." This difference may be accounted for by the fact that the principal is a new arrival from a different school, where different conditions prevail. However, it is of some interest that, throughout this study, different but quite strongly-held views on what sort of students USMES was best for (faster-slower, older-younger, affluent-deprived) were consistently expressed at different locations. We will speculate below on the interesting issue of whether this links optimal USMES effects with some particular developmental stage (whether reached by gifts or educational opportunity), or whether children in different schools have different perceptions of the autonomy seemingly offered by real problem-solving challenges.

Little was said about USMES as a tool for integrating basic skills instruction. One teacher characterized USMES as "a tool for the reinforcement and utilization of basic skills, but not an initiator of basic skills."

Apparently, quite good-quality USMES is being done at School A. Since the new principal is fundamentally sympathetic with USMES, and, at the same time, the school is under intense pressure from groups of parents with conflicting views, it struck our investigator that valuable new modes of USMES might emerge. In his words, "USMES may develop very nicely and even give us some new models that many other schools could use." On the other hand, "it is possible that some of the pressures in the school will lead to distortions in the USMES model." Our investigator notes that "ESS is the science program for the intermediate grades, but it is used in a completely individualized way without groups of children working together. This individualization, I believe, is fostered because it is easier to follow the children's learning, and also to control their behavior."

In summary, School A is characterized by its talented, privileged students, and its need to function under conflicting pressures from mutually antagonistic parent groups. In this situation, a mode of USMES well-adapted to this environment may evolve, or USMES may be distorted to the point of reduced usefulness.

School "B"

School "B" is located in the southwest of the United States, in the vicinity of a large city (population 1.5 million). Enrollment is 800. The neighborhood of the school includes a shopping center and "inexpensive houses." The racial/ethnic composition of School B students is approximately 49% Spanish surname; 49% white; and 2% black, asian, and native american combined.

The level of USMES activity at School B is very high, and significantly effects the tone of the school. Challenges are generally involved with the smooth and successful operation of the school. They are concerned with such issues as purchasing supplies, regulating traffic, promoting fire safety, improving playgrounds, and many others.

No special Design Lab space is set aside, though tools are widely used. Tools are used in classrooms (indeed, the principal suggests that Design Lab space may not be needed since the "whole building" is used). Teachers are instructed in tool use, and tools are provided through student-raised funds as well as district funds. Some teachers feel that a Design Lab space would be extremely helpful.

Time employed for USMES is derived from science, mathematics, and language arts. Of the persons interviewed, most thought there was enough time provided, though one thought there was too little, "because the class has special classes 1½ hours each day."

USMES is evaluated along with other subjects in regular district evaluations, and the district seems to be satisfied with School B's use of USMES, though not overtly supportive of it.

The principal of School B supports USMES with great vigor; we believe this is the largest single factor which accounts for the unusual strength of USMES in School B. This principal's discretionary power over curriculum is not boundless, but within its limits she has given USMES a significant pedagogical role in the school.

The social role of USMES in School B is probably even more important than its pedagogical role: it is felt that USMES "controls the atmosphere of the school," "gives students a sense of ownership," and "makes children authority figures." This is particularly important for School B, because of its culturally mixed student population, and high student turnover rate.

Apparently relations between USMES teachers and non-USMES teachers are good. Relations with the school custodian have remained friendly--evidently the custodian is "amused" by student construction activities.

The parents of School B students are not much involved in USMES, though they seem to approve of the program (and in some instances have requested their children be placed in USMES classes). Grade reports to parents characteristically take USMES into account within a particular major subject, such as science or language arts. In some cases, the discipline and cooperation of students is reflected in student citizenship reports. Evidently local pressure on teachers, principal, and district administrators to justify all work in terms of basic skills instruction is moderate. One respondent did express a desire to see USMES "correlated within subjects" but this respondent was a non-USMES teacher who might have been unaware of the extent of presently existing correlation resources.

The respondents interviewed, for the most part, seemed to agree that the effects of USMES on School B students were very positive. Students are characterized as "being more eager to learn," and "having a sense of ownership" in the school. Non-USMES teachers were divided--one reported that "kids benefit" from USMES, but another observed that "scores must go up--will making posters help?" Standardized test scores have not been systematically investigated but two respondents expressed the belief that kids did better on standardized tests because of exposure to USMES.

An attempt at doubling the number of USMES teachers in School B in 1976-77 has not been wholly successful since new USMES teachers were also newly-trained classroom teachers, and in many cases found USMES "overwhelming." However, informal peer support for new USMES teachers did prove helpful, and the principal took an active interest in new teachers. Some respondents expressed the wish that formal workshop training (such as that previously afforded in St. Louis) could be given to new teachers. Teachers at School B who use USMES with their students typically refer to it as a "way of life," or a "philosophy." Characteristically, non-USMES teachers perceive the program as requiring much less training than USMES teachers do.

The School B USMES implementation is strong and vital, and a large number of teachers at School B are now skilled enough to teach USMES on their own. However, the program "is not being dealt with in a positive way by the school district at all." Thus, the implementation is still quite directly dependent on the energetic support and personal commitment of the School B principal; otherwise, its future is not assured, though its present state is very strong.

School "C"

School "C" is located in the north central part of the United States. The school is located in a suburb (population about 25,000) and is set in a neighborhood of "moderate" to "expensive" houses and apartments. Student enrollment is about 700, consisting of 99% white, 1% black and Spanish surname combined.

Challenges done recently have been School Zoo, Design Lab Design, Growing Plants, Classroom Management, Planning a camping trip, and others.

A Design Lab exists at School "C" but it is little used. The lab is located in an unused shower room, and is characterized as "too far and too isolated from classrooms" (that is, it is not possible to supervise both students using the design lab and students remaining in the classroom, because the two are spacially too far apart). This problem was mentioned by several USMES teachers, and is quite serious, since aides are not routinely provided to help supervise separate groups of students.

Time for USMES activities is generally provided through the use of science time, free time, some social studies time, and homeroom. Typically, twenty to thirty minutes a day may be made available, three times a week. It is apparently the principal's view that finding enough time for USMES is "a big [negative] factor." The time actually provided is small compared with that in other schools.

The importance of USMES at School "C" has decreased significantly. There is now no discussion of USMES at the district level and there is a new strong emphasis in the district on traditional training in basic skills. "Keep hitting basic skills in math," is the message of current district administrators. Also, new controls and accountability mechanisms have been set up as a reaction against earlier failure in the district to follow up numerous innovative programs. Despite the fact that real problem-solving is consistent with the explicit, formal pedagogical goals of the district, it is now difficult to schedule and difficult to carry out, both because of district emphasis on "basics" and district logging procedures. It is significant that funds for the purchase of new USMES materials are available, but materials have not been bought.

Grading in USMES is not, apparently, easy, and is little done, though some grading in science, health, and language arts incorporates student performance in USMES. In general, there is little interaction between USMES and the rest of the curriculum, and only non-USMES teachers made comments such as "USMES fits in," and "[the USMES approach] is used to teach many subject areas."

Relations between those using USMES and others are not particularly harmonious. Some teachers felt that relations were satisfactory, but others felt they were deteriorating. The school custodian was reported as having been "upset by paint and animals."

There is some positive interest among parents (for example parents were willing to staff the Design Lab) but most interest would appear to be negative. Thus, a parent thought his child was in "too many" USMES units, and problems of grading, and reporting USMES activities to parents, seemed to deter teachers from the use of USMES.

USMES is not generally recognized as having had much effect on School "C" or its students. The principal finds the program as had "no effect" on the school itself, and our investigator feels that some students are actually "bored" by USMES as it is taught at the school. There is no indication that comparisons of standardized test grades have been made in an attempt to assess possible effects of USMES. On the other hand, some teachers have reported USMES units that went "very well" with their classes, and, in the view of our investigator, some School "C" teachers are teaching very good USMES.

It would appear that the nature of the student population at School "C" is changing. A large number of "transient" students now pass through the school, and it would appear the School C teachers have difficulties in dealing with them. A number of comments were made about students who were "less mature," who "could not discipline themselves," or who had to be kept separated in their seats. No doubt this change is a deterrent to USMES activity, though at least one teacher reports excellent results with a "very mixed class."

Most USMES teachers at School "C" were trained in an USMES development teacher workshop. There is not an active training program at School "C" now.

In general, teachers' views on the scope and function of real problem-solving are quite cautious. Thus, one teacher feels that problem-solving consists in finding answers to problems posed by the teacher through library work in small groups. Another sees group leadership in USMES not as an experience which may bring the retiring student out of himself, but as a role which must be assigned to pre-existing student leaders if challenges are to be successful. In another case, the "USMES spirit" is seen as little more than a style of presenting individual work (such as ESS). Clearly, real problem-solving at School "C" includes delicate group dynamics, since one successful USMES teacher observed that "kids resent being asked to plan early on!" It seems especially significant that students feel they are being "asked" rather than "allowed" to plan.

It would appear that USMES is "in trouble at School C. The reasons would appear to be these: First, it seems that teaching staff and student population at School "C" are not comfortable with each other; Second, it would appear that many teachers mistake parts of USMES for USMES itself--that is, they feel that USMES is an "approach" which can be used in individual work, or in solving teacher-assigned problems, or without using groups, or without using tools.

School "D"

School "D" is located in the southeastern part of the United States in a large city (population about 650,000) and is situated in a neighborhood containing houses of "moderate price." The school's student population is about 1600; of these about 98% are black; 2% white, Spanish surname, and all others combined.

Recent USMES units have been concerned with metrics, growing plants, and planning gifts in the lower grades; burglar alarms, restroom improvement, playground work, and others in the higher grades.

A special Design Lab area is used in School "D" and there is a Design Lab manager. The space available is adequate but somewhat small for an entire class. The operation of the lab is in general successful. The Design Lab manager is apparently quite active, sometimes discussing tool skills in individual classrooms, and space scheduling does not seem to be a major problem, though one teacher felt scheduling could be improved. A portable Design Lab cart exists, but is little used.

Time is made available for USMES under mathematics, language arts, science, and social studies. The biggest single contributor is science time, which is fixed by statute in the amount of 30-60 minutes per day, and is available for USMES. Work is done on an active USMES challenge from two to five times a week; most respondents felt enough time was available for USMES.

At present, USMES seems to be reasonably consistent with district policy as it affects School "D" both in theory and practice. Real problem-solving is one of 16 formally-stated district pedagogical goals. USMES correlates well with other curriculum materials and with SAVVY, a curriculum-coordinating program for science used in the district. "Back to Basics" is strong in the district, and, according to the principal, School "D" is a "Back to Basics school"; however, the focus of structured basic instruction in School "D" is reading, and USMES is used to complement the highly structured basic skills activity which this emphasis requires. Likewise, USMES is viewed as giving effective basic skills instruction in Science.

In general, relations between USMES teachers and others at School "D" are not strained. Recently, however, when it was necessary to transfer some teachers, the principal used his discretionary powers to retain all USMES teachers. There is some anxiety on the part of USMES teachers that others may resent this. There are, however, no signs of any resentment not associated with this specific incident, and everyone seems to agree that the principal supports USMES teachers and non-USMES teachers alike, and that he does not pressure teachers to use USMES. There has been some difficulty with custodians about "mess" but the problems have not been serious.

Reporting to parents is minimal. In fact, USMES was introduced with the promise that it was a non-graded program. In general, parents are "happy" with USMES. A moderate effort is made to keep parents informed about real problem solving--for example, a skit was presented to the local PTA--but the effort is not a strong one, and there seems to be little contention or antagonism among the School "D" parents.

Although one non-USMES teacher was under the impression that USMES had no effect on students, all other respondents seemed to agree that USMES-trained children can work better in groups. One respondent claims to be able to tell which children had been trained in USMES by their actions. No evidence had been found that USMES affected standardized test scores, either favorably or unfavorably, by comparison with other science curriculum.

Although respondents at School "D" suggested USMES for use with both slower-than-average, and brighter-than-average, students, the bulk of opinion would seem to favor use with the brighter/older students at School "D".

Many of the teachers at School "D" regard USMES as core material--many, however, regard USMES as a supplement. In general, it would appear that many teachers need to know more about USMES. Learning would seem to be a little haphazard for new USMES teachers, and many USMES teachers spoke of misconceptions they held when they began using the program. Many, however, intend to continue using the program now that they have come to understand it, and are of the opinion that "only USMES has real problem-solving."

In general, School D appears to be a good environment for the USMES program. One interesting future development planned by School D's principal is to have "at least three teachers doing USMES at every grade level," and some unifying record-keeping procedure to facilitate students getting a full but balanced exposure to USMES over several years. Thus, some mechanism would insure that a student was not exposed to the same challenge twice, etc. This principal also believes that "slower children should do USMES," and that they can benefit from it.

School "E"

School "E" is located in the mid-central portion of the United States. It is in a small city of about 50,000. The school itself is set in an urban/suburban neighborhood, of middle to low-middle class socioeconomic status. The student population is about 80% white, 20% minorities. Total enrollment is 550.

Teachers in School E frequently do several units at once. Among the units have been School Zoo, Growing Plants, Soft Drinks, Advertising, and others. A Design Lab space is available at School E and is important to the USMES done there. Materials at the lab are kept up by the principal, and the facility is described as "well supplied." One improvement sought by several respondents was a full-time Design Lab manager.

Aides, and the routine use of aides for USMES teachers, are central to the style of USMES teaching carried out at School "E". All teachers agreed on the importance of having aides, particularly for USMES, and even the wished-for Design Lab manager is conceived as an aide.

Time employed for USMES is science time, math time, and social studies "research time." Typical scheduling for USMES employs periods of rather intensive work--a "mini-course structure," with over 5 hours of USMES per week for several weeks, is apparently quite common. Respondents are divided as to whether enough total time is available.

USMES has an important role in the school (almost all teachers at the school do USMES) and is explicitly approved by the Board of Education (the principal persuaded the board of the importance of USMES). Parents are familiar with USMES through reports made to them by the school, through conferences in which some teachers report on individual strengths and weaknesses of each student, and through "scrounging" efforts by students to secure materials for construction. Parents are described as all having responded "positively to USMES," and have volunteered to help.

Relations between USMES teachers and others appear to be harmonious.

Teachers are generally positive about the program ("will always use USMES") and believe that the USMES techniques may apply to any subject if an aide is available. Teachers are eager to see new materials and be up-to-date, and in general are strongly convinced that the custodian's cooperation and flexible support on the part of the principal are critical for successful USMES. At least in the past, some training has been carried out in district-held workshops, and on a one-to-one basis.

In general, it would appear that School E presents a model of stable USMES implementation with strong mutual support among teachers, principal, parents, and the school board. The importance of aides, and the general flexibility of USMES use at School "E", are notable factors.

Summary

In Schools B, D, and E, USMES is used with considerable success, and USMES has a significant impact on the life of each school. In each case, the local USMES implementation is tailored to meet local needs and resources, but all would, in the words of our on-site investigator, "make excellent demonstration schools for USMES."

At School A, USMES is being hindered by a generally high level of conflict and mutual suspicion among teachers, administrators, and parents. However, good USMES is being taught, and students at School A are particularly receptive to taking initiative. Thus, the new principal of the school may be able to evolve a model of USMES capable of responding productively to these pressures without undergoing excessive distortion.

In School C, USMES is in decline, probably because of worsening district climate and changing student population, which seem to have put pressure on students, teachers, and principal alike that discourage the use of USMES and create an atmosphere of anxiety. However, the USMES that is being taught is generally good USMES.

INTERPRETATIVE ISSUES

USMES AND THE DESIGN LAB

The use of USMES traditionally entails the use of tools and construction facilities. The developers of USMES, by evolving the concept of a Design Lab, have sought to formulate a standard strategy for efficiently providing such facilities as add to the breadth of many USMES challenges. In this study, two empirical questions relating to Design Labs inevitably invite our attention. First, to what extent does the success of most school USMES programs depend on the accessibility and adequacy of such facilities? Second, what sorts of Design Labs are most successful?

Let us consider what sorts of facilities are available at Schools A through E, and how well they meet local needs. At School A a portable cart was used. Although there was some difference of opinion, respondents generally felt that this facility was not adequate. The lack of a Design Lab space was cited as a handicap, and it was noted that teachers might "shy away from some units" because no satisfactory facilities were available.

In School B, neither a portable cart nor a separate Design Lab space was provided. Tools were used a great deal, however, and the principal commented that a Design Lab space was not needed because "the whole building was used" for construction activities, and because students earned money to purchase necessary supplies. It is clear that School B takes a serious interest in facilitating construction activities (teachers are regularly instructed in proper tool use) and it appears that a great deal of successful construction takes place there; however, more than one respondent voiced the wish that a separate Design Lab space be made available.

One suspects that USMES has such vitality at School B it will succeed no matter what facilities are available. The success of construction activities at School B does _not_ mean that the school's solution to the Design Lab problem--no Design Lab at all--would be a generally satisfactory one. It should also be noted that construction activity at School B is not altogether financially unsupported: a $1,500 award from the district's Special Innovation Fund was employed to buy tools.

Schools C, D, and E, have separate Design Lab spaces. The lab at School C is perhaps the least satisfactory, since it is located in an unused shower room which most respondents found "too far" and "too isolated" for effective use. Complaints about the remoteness and isolation of this space should not be taken merely as complaints about inconvenience. At a school such as School C where teachers aides are not habitually used to assist in USMES challenges, teachers wishing to use Design Lab spaces for construction must divide large classes, and supervise simultaneously students in the classroom and students in Design Lab spaces. Merely "keeping order" under such circumstances is difficult if the spaces are far apart; adequate guidance and supervision becomes nearly impossible. The seriousness of this issue is borne out by the fact that one third grade teacher at School C had her students buy rather than construct cages for the School Zoo challenge. It is interesting that the situation at School C is one in which teachers' aides would be of great use in mounting a successful USMES program, since the inaccessibility of Design Lab spaces would then pose fewer problems. However, there is little tendency at School C to think in terms of aides.

School D and School E have separate, heavily-used Design Lab spaces, both of which seem to be functioning quite successfully. The lab at School D is well-funded by school and district (funding provides for acquisition of materials and salary for a Design Lab manager), and is being used to capacity. Most respondents describe the space as "just adequate" or "rather small for a whole class," and some respondents noted that Design Lab use could be "better scheduled." It would appear that it is the Design Lab manager, rather than the Design Lab tools or space, that is centrally important. There is a history of cooperation between Design Lab managers and individual teachers (for example, the manager comes into the classroom to help with tool-using skills) and the present interest of School D's principal is to secure not a better space but a full-time Design Lab manager who is an elementary school teacher with full liaison to classroom teachers. Thus, in some measure, the adequacy of funding for tools and the presence of an active professional Design Lab manager compensate for the marginal quality of Design Lab spaces available. A portable Design Lab cart, well-outfitted and provided by the principal to supplement existing facilities, has been unsuccessful. Everyone seems to agree that this cart has been little used, and the principal finds it a "disappointment."

At School E, there is much less funding for the Design Lab, but apparently the space is adequate. Design Lab use, like all other aspects of USMES at School E, is greatly facilitated by the flexible and extensive employment of teachers' aides. Indeed, it is a full time Design Lab aide that respondents from School E would like to see. The Design Lab at School E is perceived as a highly necessary facility, and the principal is concerned to maintain Design Lab material supplies. Fortunately, most materials (apart from Tri-Wall) are donated to the school.

Naturally, the information we have gathered on Schools A through E cannot serve as a basis for reliable general conclusions. However, the facts appear as follows:

- Portable Design Labs (carts) do not seem to invite much use. The reader will recall that both Schools A and D have outfitted Design Lab carts, and that neither has been much used. It is interesting that minimal use seems to be the rule both for School A, where the local USMES implementation is laboring under serious difficulties, and School D, where the program is much-used and generally respected.

- Since a great deal of construction activity takes place at School B, this one instance demonstrates that, in an environment where USMES activity is both pervasive and intensive, construction can take place with no special facility. However, there is evidence that, in schools where emphasis on the USMES program is moderate or weak, teachers are sometimes deterred from construction activities if good Design Lab facilities are not present and accessible.

- The facility of School E is physically adequate, facilitated by aides, but not particularly well funded. The facility of School D is very well funded but physically marginal. The facility of School C is physically inadequate, not particularly well funded, and not heavily-staffed. It is probably fair to say in the most general terms that the lab of School C is not adequate, but the labs of D and E are, according to the reports of most respondents. This suggests an interesting hypothesis: Merely to have a separate Design Lab space is not sufficient; however, if this space is convenient and large, or if funding exists for an active professional Design Lab manager, or if aides are readily available, the facility will probably be successful.

The second main question--to what extent does the success of an USMES implementation depend on the adequacy of its Design Lab facilities--can only be answered in the most general terms here, but the answer seems to depend on the administrative role of the person asking the question. From the principal's point of view, it would seem that a successful USMES program can be fostered with no Design Lab at all (as with School B) so long as one can use one's "whole school" as a Design Lab. From the point of view of teachers, the presence of satisfactory Design Lab facilities is probably thought to be important for instituting a successful USMES implementation. Respondents from School A and C, where most USMES activity is initiated by individual teachers, made this very clear.

There is the statistical evidence in Part A that, on the whole, USMES sessions were rated more "successful" when there were construction activities. However, that evidence did not indicate whether or not Design Labs were used for the construction activity.

Teacher's Aides

It is interesting to note that, in Schools A through D, teacher's aides played a small role in facilitating USMES activities, whereas in School E, aides were much used and held to be of the greatest importance. It is further interesting to note that, unlike certain universally-recognized desiderata such as access to Design Lab space, the use of teacher's aides is not always felt to be important. Likewise, our intuitive feelings that the use of aides ought to be somewhat helpful is balanced by statistical findings, reported in Part I of this study, which indicate not only that the presence of aides has no significant general beneficial effect (Page 6.1.14), but also that the presence of an aide does not even conduce to more construction activity taking place, on a session-by-session basis.

Our tentative assessment of the matter is as follows. Based on the statistical data given in Part I of this report, it would appear that the absence of teacher's aides does not "spoil," or materially hamper, units actually attempted; on the other hand, the School E respondents indicate that the absence of teacher's aides would have deterred them from attempting certain units. Thus, it would appear that, if teacher's aides have an overall importance to USMES programs, it is in encouraging teachers to attempt more units, rather than materially affecting the quality and success of units attempted. Furthermore, among the five schools studied, local conditions strongly influence the role of aides:

- In School E, a separate Design Lab space was available but not staffed by a full-time manager; principal cooperation made getting aides easy; and classes were large. Thus, the potential role of teacher's aides was extremely significant.

- In School A, with its portable Design Lab cart, facilities for construction activity were poor, and there was no motive for physically dividing students during USMES sessions. Thus, aides were not used, and the need for them was not felt.

- In School B "the whole building" was used for construction activities. Likewise, USMES activities were perceived as the foundation of, rather than a challenge to, order and discipline. No serious need for aides was perceived.

- School C is somewhat perplexing, since a remote but separate Design Lab facility did exist, and since discipline was a serious problem but, for some reason, no need for teacher's aides was felt.

- In School D, the presence of a salaried and deeply involved Design Lab manager, capable of bringing tools and expertise to the classroom, combined with the relatively small size and marginal physical character of separate Design Lab spaces, made the issue of dividing classes relatively noncritical. Hence, in School D, no particular emphasis on aides was in evidence.

The Scheduling of USMES Units

USMES challenges, when conducted at Schools A through E, appear to have been held somewhat more frequently than the 2.0 times per week cited as a mean frequency in Part I of this study. On the other hand, sessions especially Schools A, C, and E, appear to have been shorter than the mean 61 minute length reported in Part I. The schools would appear to fall in three main groups:

- Schools B and D. In general, respondents said little about the exact amount of time used for USMES session. The implication was that they were free to use time as available.
- Schools A and C. Respondents gave quite detailed information about the number of minutes available for USMES session. In general, time periods cited were substantially shorter than the 61-minute mean length reported in Part I of this study (generally 20-50 minutes). The implication was that teachers were expected to use specific time-slots which could be justified in terms of specific curriculum activities.
- School E. Although scheduling seems quite rigorous and sessions (apparently) limited in length, a "mini-course" technique of scheduling USMES challenges intensively (in excess of 5 hours per week) for a several week period was employed, perhaps to correct for the fragmentation involved in short USMES sessions. The results seemed quite good.

Respondents from School B and D (except for one School B respondent whose class had special activities one and one half hours each day) reported that they had "enough time." Respondents elsewhere were divided, perhaps more according to individual teachers' conceptions of USMES and classroom skills than according to actual scheduling opportunities. The principal of School C spoke of time as a "big factor" in scheduling USMES; by this she meant she was concerned that USMES took too much time.

Though this sentiment was not expressed by other respondents, it points to a problem which none of our schools could escape: namely, finding the time, sufficiently compact and sufficiently extensive, to support a good USMES implementation. External factors made this very easy in some cases, very difficult in others. A natural procedure is to schedule USMES as mathematics, science, language arts, or social studies, according to the nature of the challenge being carried out. In many instances, district-imposed constraints or community attitudes made these subjects particularly resistant to discretionary change at the individual classroom level (or even at the school level). In general, however, no alternative strategies for scheduling were seen to exist.

Schools B, D, and E are most successful in solving scheduling problems. Evidently the principal of School B quietly treats USMES as "core" material from a curriculum-planning point of view, while she points to the dramatic and extremely positive effects of USMES at her school as a discipline- and morale-builder. In general, she proceeds with the approval of her district, but without positive district support.

The USMES implementation at School D is carried on with more positive district involvement, both in terms of funds and overt support. The principal of School D uses USMES as "core" curriculum material, but explicitly poses the rather freely-structured USMES experience in science and mathematics as a complement to his very rigorous, highly-structured program in language arts. Under these conditions, he can quite accurately characterize School D as a "back-to-basics schools," giving him personal credibility in the eyes of conservative elements in his community.

At School E, scheduling problems are softened by the use of aides, a high degree of cooperation among faculty, and a high degree of "saturation"--most teachers are USMES teachers. The principal of School E is able to proceed without much concrete district support (at least in terms of funding), but has secured the approval of the Board of Education for his USMES activities. This approval, while it may not relax district curriculum guidelines, does make USMES "respectable," so that this principal is free to mount a very conspicuous USMES implementation, with aides and flexible scheduling and overt administrative sponsorship.

School A is an unusual case, since district science objectives explicitly recognize USMES, while community conflicts and parental pressures make it necessary to find additional justification for the use of USMES as "core" curriculum. No stable arrangement has been worked out, but the new principal of School A has speculated that a place might be found for "interdisciplinary" study in the curriculum, if objectives could be identified and progress verified by testing.

In School C, little is done to "find time" for USMES at the school level but the School C principal does not prevent individual teachers from doing USMES when they can.

From the information collected on Schools A through E, it would appear that a number of avenues exist whereby resourceful principals who wish to use USMES can schedule the program. It is interesting to note, however, that none of the three most successful methods (used in Schools B, C, and E) represent formal alterations to curriculum guidelines. Conversely, in the one instance (School A) where district guidelines explicitely support USMES, formal endorsement seems to afford little real support. Apparently the best solution to the scheduling problem is different under different circumstances; probably, also, there are situations in which USMES scheduling cannot reach satisfactory levels until basic problems of trust, communication, and cooperation have been to some extent relieved.

Where USMES scheduling is taking place under difficult circumstances, and where such difficulties take the form of stringent accountability and planning constraints, USMES teachers and principals frequently report that they are hampered by being unable to offer an advance account of precisely how much exposure to which basic disciplines will be afforded by a particular series of USMES class sessions. It is, of course, inherently the case for all real-problem-solving activities that the formal subject-matter to be "covered" in class sessions cannot be rigidly controlled, and cannot therefore be infallibly predicted in advance.

However, it is possible to estimate probable amounts of basic skills exposure which may reasonably be expected for each hour of time devoted to a certain USMES unit, based on the 1043 Class Session Reports analyzed in Part I of this volume. One Table, showing such estimated value, is given below. The reader should be cautioned that certain radical simplifying assumptions underlie the estimates tabulated. They are the following: (1) if any portion of a particular class session affords training in one of the basic skills areas shown, such instruction is presumed to last throughout that class session; (2) for purposes of computation, the mean session-length is taken to be 60 rather than 61, minutes; (3) USMES activities are explicitly assumed to be integrative--that is, it is explicitly assumed that instruction in more than one basic skills area can take place during a given time period.

Minutes of Basic Skills Instruction Per Hour of USMES, by Selected Units (Integrative)

Unit	Mathematics	Language Arts	Science Concepts	Social Studies	Number of Sessions
Bicycle Transportation	45.	53.	53.	60.	24
Classroom Design	49.	45.	43.	52.	78
Classroom Management	45.	38.	15.	15.	8
Consumer Research	40.	38.	23.	38.	162
Describing People	36.	47.	19.	55.	38
Independently Developed Unit	23.	38.	19.	49.	32
Designing for Human Proportions	9.	17.	26.	43.	7
Dice Design	60.	48.	12.	0.	10
Getting There	40.	0.	8.	32.	15
Growing Plants	39.	48.	46.	26.	78
Lunch Lines	30.	54.	30.	51.	28
Manufacturing	47.	32.	27.	38.	164
Mass Communications	23.	30.	0.	8.	8
Nature Trails	48.	15.	8.	2.	39
Orientation	27.	47.	11.	51.	42
Play Area Design Use	34.	60.	21.	51.	14
Protecting Property	27.	37.	26.	26.	37
School Supplies	49.	41.	26.	0.	16
School Zoo	36.	30.	38.	44.	110
Soft Drink Design	53.	58.	36.	36.	25
Ways to Learn/Teach	39.	49.	27.	34.	86
Weather Predictions	55.	55.	44.	14.	22
Totals/Other	40.	40.	29.	37.	1043

Since many educators may not wish, a priori, to accept assumption (3) above, another tabulation is offered below in which the contrary assumption--that instruction in one basic skills area "blocks" instruction in another--is employed. For these purposes, where the total of mean basic skills instruction times for the four listed disciplines exceeds 60 minutes to the hour, all estimates have been proportionately reduced. The "blocking" assumption reflected in the figures below may appear absurd to many readers, but it has the advantage of generating a set of "conservative" values, which need not be explicitly justified in terms of integration:

Minutes of Basic Skills Instruction Per Hour of USMES by Selected Units (Proportional)

Unit	Mathematics	Language Arts	Science Concepts	Social Studies	Number of Sessions
Bicycle Transportation	13.	15.	15.	17.	24
Classroom Design	16.	14.	14.	17.	78
Classroom Management	24.	20.	8.	8.	8
Consumer Research	17.	16.	10.	16.	162
Describing People	14.	18.	7.	21.	38
Independently Developed Unit	11.	18.	9.	23.	32
Designing for Human Proportion	5.	11.	16.	43.	7
Dice Design	30.	24.	6.	0.	10
Getting There	30.	0.	6.	24.	15
Growing Plants	15.	18.	17.	10.	78
Lunch Lines	11.	19.	11.	19.	28
Manufacturing	19.	32.	11.	16.	164
Mass Communications	22.	30.	0.	7.	8
Nature Trails	40.	13.	6.	1.	39
Orientation	12.	21.	5.	22.	42
Play Area Design Use	12.	22.	8.	18.	14
Protecting Property	14.	19.	13.	13.	37
School Supplies	25.	21.	14.	0.	16
School Zoo	15.	12.	15.	18.	110
Soft Drink Design	17.	19.	12.	12.	25
Ways to Learn/Teach	16.	20.	11.	14.	86
Weather Predictions	20.	20.	16.	5.	22
Totals/Other	17.	16.	12.	15.	1043

The reader is cautioned that both Tables contain only estimates, based on radical simplifying assumptions. Both are subject to the challenge that small groups working on different aspects of a problem may not communicate, and that basic skills exposure afforded to one group may have no effect on another. Likewise, the second Table, which assumes "blocking," does so in a somewhat simplistic fashion, since it proportionately reduces mean values rather than inspecting each session for multiple basic skills entries, and proportionately reducing just those entries.

Furthermore, all figures in both Tables are parently absurd is one assumes that basic skills instruction in a real-problem-solving curriculum takes place in discrete episodes, alternating with rather than inherent in problem-solving activity, since the mean number of basic skills being treated at any given time appears to be at least 1, for every challenge in both tables. Values more in line with this assumption might be derived from the first tabulation given above, by selecting arbitrarily some fraction of an hour, assuming that all skills-instruction episodes were of that particular duration, and multiplying all quantities in the tables by that number. Unfortunately, this would yield misleadingly low values, since it would, in turn, entail the assumption that only one "episode" in each of the four basic skills area could take place within a single class session.

All the figures given above reflect mean values only. In some USMES sessions, no basic skills instruction takes place; in others several kinds may take place. Nevertheless, these tabulations of means may be helpful for planning purposes.

USMES and the Local School District

The interaction between USMES and the local educational "climate" prevailing in the district to which the USMES school belongs takes very different forms among the five cases studied.

School A is part of a district divided by profound conflicts; local attitudes towards USMES are likewise deeply conflicted and inconsistent. On the one hand, USMES correlates "very well" with stated district pedagogical objectives, and is specifically "written in" to the science objectives of the district. Indeed, district documents recognize USMES explicitly and minutely (down to the individual unit level) as providing activity for instruction in science processes. Thus, "on paper," the district affords an ideal climate for USMES. It is significant, however, that this apparent endorsement of USMES in district guidelines, and the extensive and excellent USMES work done in the past at School A, reflects the influence of only one of two deeply antagonistic and opposed groups within the district. A fact which, ironically, is not reflected in district pedagogical guidelines, is that conservative forces within the district and community have recently effected sweeping (if not necessarily conclusive) changes, replacing "progressive" personnel where possible and imparting a strong "back-to-basics" emphasis to district policies and accountability procedures. The principal of School A at the time of these changes was replaced, and another individual was brought in to "bring order" and implement new district emphasis on basic skills instruction. The resulting situation is ironic, since this principal is himself quite sympathetic to USMES, though conservative forces in the district are generally critical of such programs. This irony is compounded by yet one more remarkable fact: this principal wants to develop USMES as a program for gifted students, whereas USMES teachers remaining at School A perceive the program as most effective for helping slower students.

Intuitively, one might imagine that a district (such as School A's district) in which opposing educational philosophies are strongly represented might operate in either of two quite different modes. Conceivably, if opposing views could win proponents at all levels, a healthful and challenging environment might arise in which competing techniques (free and structured, innovative and traditional) would exist side-by-side in a competitive rather than a preemptive conflict. Presumably in that situation, the best in traditional teaching as well as the best in innovative teaching would be demanded of all participants, and USMES could coexist vigorously with other teaching methods. On the other hand, a situation might arise in which factions competed preemptively--struggling through administrative means such as altering the form of accountability procedures, instituting directives and guidelines, or purging uncongenial teachers and administrators. In cases where a struggle takes this form, if the result is anything less than complete victory for one group, one might expect both groups (here, both conservative and "innovative") to be somewhat thwarted by adversary stratagems.

It would appear that School A finds itself in a situation largely of the second kind. Thus, the future of USMES at this school is problematic, and depends on the development of a mode of USMES which can satisfy minutely particularized curriculum requirements, conform to stringent accountability and grande-reporting procedures, and survive periodic changes of faculty and principal, without attention.

The relationship between USMES and school district at School B is, by comparison, very simple. The district neither helps nor hinders USMES. This district is "innovative on paper," but dedicates funds to programs in basic skills instruction. In general, the "method" of School B's principal is to do USMES on her own authority with school funds. Her great success in using USMES to build morale and discipline at School B, allows her to proceed in this essentially neutral district without being challenged; indeed, School B's success have won it occasional funding.

The district to which School C belongs has recently come to place a very strong emphasis on basic skills instruction, at least in its day-to-day policies. As is true in School A's district, USMES is still consistent with school system goals overtly set down, but is currently discouraged by newly-instituted logging and controls procedures, and interacts little with the rest of the curriculum. It would appear that the district is now distinctly uncongenial to USMES. Whereas neither district or school principal has attempted to make experienced USMES teachers stop using USMES, district policies deter new teachers and have prevented School C's principal from supporting USMES in any positive way.

School D's parent district supports its USMES program. In our view, this is due not only to the fact that School D's district inherently favors real problem-solving, but also to the fact that USMES at School D is part of a very successful overall program, in which tightly-structured programs (for example, the language arts program) as well as freely-structured programs (for example, the USMES program) play important roles. Thus, we feel, School D's principal offers his district a strong, balanced "package" of which USMES is an integral part.

School E carries on its extensive USMES program without district funding, but with the explicit endorsement of its Board of Education. Under these circumstances, USMES can assume a prominent place in the school's curriculum, and a rich school-wide administrative support system can be used to facilitate USMES; furthermore, teacher's aides can be employed freely (and in School E, they are so employed). School board support was initially sought and secured by the personal efforts of the present school principal.

Obviously, the foregoing is too diverse to support many generalizations. However, it is probably safe to say that (1) district support (and indeed, district approval) of real-problem-solving is no longer "automatic" even where formally specified district goals and policies would seem to make this inevitable; (2) on the other hand, district approval can frequently (though perhaps not always) be secured by a resourceful principal, even in districts not particularly disposed to real-problem-solving programs, if obvious benefits are displayed (School B) or a powerful, "balanced" program, incorporating structured and non-structured activity, is offered (School D).

It is a striking fact that school districts must be continually motivated to support a program such as USMES. The problems of Schools A and C dramatically show how rapidly even overt, formal district support of innovative programs can be lost.

USMES AND ITS EFFECTS

It may be of some interest to review here our interview respondents' comments on the effects of USMES.

USMES and the School Environment

Where USMES is successfully implemented, it generally has a strong effect on the atmosphere of its school. Sometimes this effect is difficult to describe in concrete terms, but in other instances specific results are apparent. Thus, a metric coloring cookbook developed at School D through an USMES challenge received newspaper and radio publicity for itself, for USMES, and for the school. Likewise, at School B, many practical improvements to the living environment have taken place as a direct result of USMES challenge activity. Respondents at the relatively "successful" schools (B, D, and E) commented quite frequently on the social effects of the program, that USMES "makes teachers feel better about this school," "gives children a sense of ownership," "controls the atmosphere of the school," " helps deal with a discipline problem which existed," etc. At schools where USMES is relatively little used, or is used specifically on an individual basis by particular teachers (Schools A and C) USMES seems to have little effect on the school proper (though student effects may take place). In fact, principals of both these schools explicitly characterized USMES as having "little or no effect" on the school.

Only one respondent felt that USMES had a negative effect on any school. A non-USMES teacher from one of the "successful" implementations, this respondent observed that "discipline seems to have fallen apart a bit" as a result of USMES use. Conceivably, this was a reference to the personal styles of local USMES teachers only, since the same respondent characterized USMES as a "good idea and a good program."

USMES and Student Effects

Among the effects on students noted by respondents were the following:

- "USMES kids' inquiry skills are more defined than others. They zero in on a topic."
- "USMES helps kids follow directions."
- "Kids' attack a problem better. They know what to do."
- "Socialization goes on between kids."
- "Slower kids come forward."
- "Kids with learning problems can become real leaders."

- "USMES gets kids to work well together."
- "Kids in USMES work better in groups."
- "Kids work in groups better after USMES; [one] can tell which [students] used USMES before."

This list is not complete, but represents the tone of respondents' replies. Negative effects of USMES on students were not cited even by respondents who were skeptical about the value of USMES.

Possible Effects on Standardized Test Results

There was no quantitative evidence known to any respondents displaying a significant effect, positive or negative, of USMES on standardized test scores. The impression of some respondents seemed to be that USMES had improved tests scores. Some of the comments were as follows:

- " [Teachers] believed kids did better on Iowa tests."
- "Math scores are up: [teacher believes] USMES helped [test scores] ."
- " [Teacher] feels that USMES would improve reasoning and help on tests."
- "Class is improving in language arts and in basic mathematics."
- "USMES seems to have no effect on standardized tests."

SUMMARY

The interpretive findings of this section were roughly as follows:

- Adequate Design Lab space, Design Lab tools, an active Design Lab manager, and readily available help from aides are all important to the development of a strong USMES implementation. However, no one of these items is, in itself, essential for success. There is some evidence that, within this group, strength in one area can compensate for weakness in another.

- Finding time to schedule USMES activities is a matter of major importance in developing a successful USMES implementation. In general, school district curriculum guidelines, whether favorable to real problem solving or not, have little effect on scheduling problems. More important factors are: school board support for USMES; and success on the part of the principal in integrating USMES with the total school program.

- USMES is more successful in some types of districts than in others. Among the less important factors seemed to be: district curriculum guidelines and other statements of educational philosophy "on paper," concerning the importance of real problem solving; grade reporting forms (how "naturally" they permit USMES reporting). Among the more important factors are: current "climate" of educational philosophy in the district (positive or negative towards real problem solving); extent to which the educational activity of the district is implemented through pre-reporting accountability procedures (USMES is relatively hard to report on before it happens).

  District financial support is very helpful in some cases, but other successful implementations do without it.

  USMES seems to thrive in a "back-to-basics" environment if it is viewed as part of a basic-skills-oriented curriculum.

- Both student effects of USMES and general effects on the schools seem to be positive in the more successful implementations studied. In the less successful implementations, student effects are positive and school effects are negligible. No respondents interviewed in this study had attempted to test the significance of school or student effects by quantitative means.

SPECULATIVE ISSUES

USMES AND PARENTS

Parents' response to USMES appeared to be of two types. Parents generally satisfied with their children's education were, at worst, content with USMES, and, at best, inclined to single out USMES for praise; parents generally dissatisfied about their children's education showed mixed reactions, but sometimes singled out USMES for criticism. This division (roughly between Schools B, D, and E on the one hand, and Schools A and E on the other) is not, perhaps, surprising, since USMES readily lends itself to praise ("real-problem-solving, not artificial problem-solving") or censure ("letting children drift, as opposed to teaching them something").

Let us review parental reactions to USMES in the five-school study. The parents of students at School A are as vocal, and as divided, about USMES as they are about everything else. Some parents are charmed by their children's enthusiasm for USMES. In many instances, however, parents are dissatisfied, and they do not see real-problem-solving as a "high-priority" ingredient in their children's education. Furthermore, parents at School A seem to want continuing evidence of basic skills advancement for their children--something which can be best provided through a program which provides for individual, rather than group, work, and daily homework assignments.

Parents at School A reacted negatively when they saw a play written and produced by their children as part of an USMES challenge. Apparently they felt the play was "amateurish." Respondents who tried to account for this reaction suggested that parents were unaware this play was entirely the work of their children, and speculated that, had the play been properly introduced and its education value expounded on, no negative reaction would have been forthcoming. We are inclined to take the matter a bit more seriously.

It seems to us that parents' reactions here may reflect a rather general objection, motivated by strong "commonsense" arguments, which can be levelled against USMES in environments such as School A. Children, it might be argued, learn from their environment; and when there exists an obvious discrepancy between the perceptions of children and the perceptions of older, presumably more enlightened, members of their culture on how something should be done (in this dase, for example, parents perceived the student play as "amateurish"), it is part of any natural learning process for children to be made aware of the discrepancy, so they can make process toward learning cultural norms. Thus, for example, students best learn to produce good plays by producing the best plays possible, enlightened by the criticism of adults.

Counter-arguments are easily found--that learning through real-problem-solving is deeper, better motivated, more integrative, less alienated, more permanent, etc.--and in some schools they are borne out with dramatic clarity. However, the applicability of these arguments, and the clarity with which student response shows them to be true, varies from school to school. In the case of School A, such counter-argument may need to be presented vertally, and with some subtlety. This, of course, goes somewhat beyond merely informing parents about USMES activities.

A survey taken among School A parents of one class show that 90% believe USMES to be valuable and 10% believe it to be "a waste of time."

The situation at School B is simpler. Parents trust the school, and, furthermore, see the results of USMES everywhere. In general, they are not involved directly with USMES, but they are wholly satisfied with it. Some parents at School B have actively requested that their children be placed in USMES classes.

School C parents are more disposed to participate actively in USMES--for example, parents have volunteered to staff the USMES Design Lab. On the other hand, parental attitudes toward USMES are divided. Some parents are pleased, but some have felt their children were in "too many USMES units." In general, it is our belief that negative parental response is a minor problem at School C, by comparison with those arising from district influence, staff, and changes in student population.

School D. It is interesting that, while parents at Schools A and C are to some extent disturbed at the scantiness of individual grading and progress-checking under USMES, parents at School D are delighted with USMES, having been promised that USMES would be a special non-graded program. The contrast in parental expectations and psychology is dramatic.

At School E, parents are pleased and satisfied with USMES. USMES is merely explained, rather than justified, to the local PTA, and USMES is frequently reported on in grading (under appropriate areas) and in conferences. Parents are indirectly but repeatedly involved in USMES through their children's material-scrounging activities. It would appear that USMES, with explicit approval from the local Board of Education, is treated quite matter-of-factly as a regular part of the curriculum of School E.

In general, it is clear that parental attitudes toward USMES vary enormously. Some of the causal variables would seem to be:

- The degree to which parents trust their children's schools

- Parents' personal feelings about graded versus non-graded activity
- Parents' disposition to become actively involved in USMES
- Parents' personal expectations of children

It seems clear that, unless these factors are taken into account, no effective USMES implementation can be assured of parental approval.

TEACHERS' CONCEPTIONS OF USMES AND REAL PROBLEM-SOLVING

An extremely important factor in the success of any USMES implementation--more important, perhaps, than funds, space, or even commitment--is what teachers involved in the program actually believe USMES to be. Though, the same could be said of any curriculum program, the concepts underlying USMES are especially subtle, and distortions can easily take place.

Informants interviewed for this study disclosed many different views on what the "essence" of USMES was. Among them were the following:

- USMES "stimulates talk" and "breaks up the routine." Some informants viewed USMES chiefly as a form of activity which relieved tensions and afforded some escape from structured aspects of the educational environment. Such informants praised USMES, but apparently did not regard it as a primary educational activity. Rather, they seemed to regard it as an atmosphere-improving program, one which might be able to create an atmosphere condusive to learning through activing as an antidote to constrants in the school environment.

- USMES turns over curriculum decisions to children. One informant believed that the distinguishing feature of USMES was its "turning over curriculum decisions to children." Though this respondent neither praised nor criticized USMES so understood, it is easy to imagine what form praise or criticism might take. One might praise such a program on psychological grounds, speculating that children would be motivated to follow a curriculum selected by themselves. Criticisms would be in terms of children's ignorance concerning their own curriculum needs.

- USMES is having children collect data. Some informatns indicated that the "chief difference with USMES" lay in the fact that "children collect data" for themselves.

- USMES offers individualized instruction. One of the perspectives on USMES encountered among respondents was that it provided "individualization." This was generally cited as a positive feature of the program.

- USMES acts as a supplementary educational activity. Many respondents cited their own or others' views to the effect that USMES was a "supplementary" educational activity. In general, the sense of this observation was that USMES is suitable for exercising, but not introducing, "core" material. The principal of one of the most successful schools studied estimated that half of that school's teachers regarded USMES as primary "core" instruction, half as supplementary.

- USMES is peripheral educational activity. Some respondents have noted that they "can't relate USMES to more important things, like language or reading." Presumably they felt that USMES teaches something, but does not deal at all with basic skills and concepts. It is not surprising that these respondents were non-USMES teachers.

- USMES entails student autonomy. A number of respondents saw, or had initially seen, USMES as characterized chiefly by student autonomy in working challenges.

- USMES is a "spirit" of presentation. Some respondents, here, as in all USMES studies, clearly regarded USMES as a "spirit" of presentation. Different respondents may have viewed this "spirit" differently, but it seems likely that most had in mind a gentle, motivating style, based on dialogue between teacher and student. In general, these respondents believed that not only any subject matter, but any curriculum material, could be presented with this "spirit."

- USMES is an educational philosophy. Many respondents, particularly experienced USMES teachers, seemed to regard USMES as an educational philosophy or an educational "way of life." In general, these respondents, though in some cases they believed USMES to be usable with a wide range of subject material, did not believe USMES to be consistent with all curriculum programs and all teaching methods.

- USMES entails construction. Some respondents, particularly non-USMES teachers, regarded USMES as a program of "hands-on" construction activity, pure and simple.

Actually studying the classroom practices of respondents is beyond the scope of this study. However, it may be helpful to consider how each view given above relates to the views of USMES project developers, and to speculate how each might affect USMES teaching in the classroom.

The view which values USMES chiefly as a corrective or antidote to excessive "structure" in a school did not originate with the USMES project developers, but it would seem to be partly confirmed by the effectiveness of successful USMES activities in "loosening up" particular schools or teachers. For example, one of the purposes of USMES at School D was to function as a counterpoise, complementing a highly-structured language arts program. It is only in some of its implications that this view is misleading. The notion of an "antidote" suggests that USMES may be effective in small "quantities" and that it may be particularly helpful in a tense, difficult situation perceived by students as being over-structured. Unfortunately, the very opposite seems to be true--USMES seems hardest to do, and least successful, in a tense, overstructured environment, and relatively less efficient when done infrequently. Not only is it practically difficult to "administer" real problem-solving in small doses, it is virtually impossible to develop the full intellectual depth of an USMES challenge in a short time.

The view that, in USMES, children "determine their own curriculum" is not correct except for aspects of detail; yet it is easy to see how such a view might have arisen. If in a course of an USMES challenge, students are permitted to study specifically what they find necessary, the impression that, in the long run, they "determine their own curriculum," may arise. Still, whatever might be the advantages or disadvantages of a program which did allow children to specify their own curriculum, it appears that USMES does not; rather, "curriculum" within a challenge is determined by the needs of that challenge. Of course students have freedom to assess what these needs are, but assessing such needs is far from making an unguided choice.

The view that it is students' collecting their own data which distinguishes USMES from other curriculum programs is understandable, since student data-collection is one of the most common visible manifestations of USMES activity. However, such data-collection is not regarded by program developers as the "essence" of USMES and real problem-solving; rather, it is a technique frequently employed by groups of students to serve the end of real problem-solving.

The view that student autonomy is a criterion of USMES is in some respects correct, but an over-emphasis on student autonomy may lead to some misunderstanding of the program, and to ineffective practices. For example, some teachers interviewed appeared to have given a good deal of thought to the problems of "guiding" an USMES class through its natural student leaders. This sort of recognition of student autonomy (verging on diplomatic "recognition") should not be necessary except where a class is particularly difficult to control. Furthermore, to think in these terms may be to lose sight of one of the most important properties of group real problem-solving: that when a class is placed in a novel situation (such as in the midst of an USMES challenge) it functions differently (with different goals, different potential leaders, etc.) than in a normal classroom or playground situation. An emphasis on "autonomy" for the class obscures the fact that it is a group organized for real problem-solving which is to be given some freedom, not the class in its preexisting social organization.

The notion that USMES offers "individualization" in its narrow sense (of students working independently of each other) is not consistent with the view of project developers. According to its developers, USMES is group-oriented, not individually-oriented. This view (which was held by several respondents) probably reflects a recognition of the way that USMES is different from traditional whole-class instruction in being capable of responding to the individual needs and strengths of students. This constitutes an accurate (and complimentary) insight concerning USMES, but may lead to difficulties if an attempt is made to merge USMES with other curriculum programs which are really organized in terms of individualized instruction. Of course the temptation to do this may be great in some environments, particularly where a school is under pressure to provide continual grading and progress-assessment, since this is relatively easy to do in an individualized program, and relatively hard to do in a group-oriented program.

The view that USMES is a supplementary, rather than a "core," educational activity, if not inherently true, is at least "self-fulfilling" in the case of any individual teacher. That is, a teacher who views USMES in this light cannot afford the time to allow USMES to develop its full depth in cognitive organization; however, unless this happens, USMES really can not carry the burden of "core" instruction unaided. Although USMES has attractive features as a supplementary curriculum, when it is used in this way it falls far short of its potential educational impact.

The view that USMES is a peripheral educational activity (held by teachers who, for example, "can't relate USMES to more important things like language or reading") would be categorically denied by the developers of the program.

All parties seem to agree that USMES is a demanding, ambitious, and time-consuming program; if USMES dealt with peripheral material only, it would be impossible to justify the trouble of implementing it.

The USMES "spirit," versus USMES as a "philosophy." It has become clear, in the course of many interviews for this and other studies, that two very different conceptions of USMES, each of them present in many respondents, receive outward expression in very similar ways. On the one hand many respondents, especially experienced USMES teachers, have come to view USMES as a "philosophy." Such comments as "the techniques may be applied to any subject if an aide is available," "USMES is a way of life," reflect this attitude. On the other hand, many respondents seem to regard USMES as a "spirit" (perhaps a cooperative or non-authoritarian spirit) of teaching, and are inclined to view USMES challenges and materials merely as material suitable for embodying such a "spirit." These respondents may feel that they have "always done USMES without knowing it," or that it is possible to use all curriculum materials in this "spirit."

These two views are frequently expressed with terminology reversed (someone may say "philosophy" with they mean "spirit"), and are outwardly similar in that they both entail some notion of extending USMES beyond the set of published USMES challenges. However, those we refer to as the "philosophy" group feel USMES can be extended to new subject areas, and the "spirit" group believe USMES can be applied to other (usually all other) types of fully-developed curriculum materials. In general, the developers of USMES affirm the views of the "philosophy" group. However, they doubt that USMES can be made to merge with other sorts of curriculum materials, as the "spirit" group maintains. There seems to be some evidence confirming this feeling, since members of the "spirit" group often find published challenges "too difficult." It seems probably that these respondents' conception of USMES is incomplete in some essential way, and that this prevents them from doing prepared challenges effectively.

The view that USMES is a "philosophy" would appear to be substantially correct. However, it has misleading implications, particularly for those who are just becoming familiar with the program. Thus, a "philosophy" might seem to be something which can be communicated abstractly, independent of particular curriculum materials. This does not seem to be true of USMES, as many respondents' views on the USMES "spirit" make painfully clear. Likewise, a "philosophy" might seem to be independent in practice from any particular curriculum materials; that is, it might seem that a "challenge" could be developed for any real problem. This is, of course, an empirical matter, but the assumption is probably false. Not all situations lead to challenges with the characteristics that make them valuable experiences in the problem solving process.

Most respondents held accurate partial views on the essential nature of the USMES program. This general tendency is, perhaps, merely a realization of a natural human desire to "pin down" the essential ingredient of USMES teaching, the criterion to determine, in a given case, whether USMES was being "done" or not. It would appear, however, that USMES is not a procedure delimited by a criterion (or criteria), but a human interactive phenomenon which can be expected to occur between students and teachers provided that most of a set of critical requirements is satisfied. All five of the existing USMES implementations studied could in our opinion be substantially strengthened if all teachers could be led to adopt this view.

TEACHERS' OPINIONS CONCERNING USMES

While it is, of course, impossible to properly represent the full range of teachers' opinions concerning USMES, or even the full range of such opinions encountered in the interviews of this study; however, it is probably useful to report and comment on some of these.

USMES and Basic Skills

A wide range of opinion concerning USMES and basic skills instruction exists among the respondents. Some respondents felt USMES had nothing to do with "core" subject matter, such as reading and other basic skills; some felt USMES was properly "a reinforcement and utilization of basic skills, not initiator of basic skills;" some saw USMES as a significant integrating device for presenting and exercising basic skills in centrally important curriculum areas such as mathematics, science, language arts, and social studies. This range of opinion not only reflects, but also determines, a corresponding range of USMES practice. It is easy to see how this happens, since a teacher who believes in USMES is peripheral will, necessarily, feel not at liberty to give it much time, not to rely on it for the exposition of basic skills materials.

Naturally USMES is valued in some schools for purposes other than basic skills instruction--for example, at School B, a great deal of emphasis is placed on USMES as a source of motivation, discipline, and morale among staff and students. However, even in such instances, it is not possible to devote large amounts of time to the program unless one trusts it (as does the principal of School B) to deliver "core" subject instruction as well as socializing effects.

Correlation of USMES With Traditionally-Designated Subject Matter

It is the opinion of most respondents that correlations between USMES activities and traditionally-designated subject areas could be detailed and justified. Several respondents felt that an account of such correlations woule be useful to them in many ways. One already-existing document, the USMES Curriculum Correlation Guide,* is the program developers' attempt to describe subject-area correlation for USMES units. Of course, it is the nature of such a "guide" that it is the possible treatment of subject-area material in connection with particular challenges, rather than assured treatment, which is tabulated. Thus, such a guide cannot help teachers or administrators to substantiate curriculum correlations to skeptical parents or administrators.

Part I of this study attempts to make (and substantiate) certain very general claims concerning frequency-of-treatment for curriculum materials--claims expressed in terms of the general "subjects" mathematics, science, language arts, and social studies.

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*Now being incorporated in the USMES Guide.

Real Problem-Solving As a Learning Activity

Opinion among respondents was divided on the subject of whether group-structured real problem-solving is, by its nature, an education activity, or whether substantial supplementary activity is required to make it so. Most felt it was educational in its very nature, but some feared that students might "start making things and stop learning," or felt that, to profit from real problem-solving activity, students needed to "see an end result" at an early stage. This latter view was chiefly prevalent among inexperienced USMES teachers or non-USMES teachers, but seemed to represent an "outside" view.

Student Involvement

The power of USMES to engage and involve students of all types seemed to be its most-praised attribute. However, in some instances (chiefly at School C) student involvement was less intense. In that school, students were sometimes "bored" by USMES and it was observed that students who were not already leaders frequently did not become involved.

Chaos

It is almost inevitable that some teachers, particularly those who have not seen USMES "up close" or perhaps have not seen it at all, may fear USMES as a source of chaos. Thus, even at successful USMES schools such as School B, we found a respondent who "doesn't want to have any part in having kids run up the wall." This point-of-view, which sees USMES as somewhat anarchic, is easy to understand, since USMES looks and sounds less orderly than traditional instruction, and is organized in a way which is comparatively difficult to explain to a casual inquirer.

Many experienced USMES teachers feel that USMES is quite orderly, and seem to be thoroughly "addicted" to using it with their classes. Interestingly enough, the existence of such "addicts," who seem to derive a personal sense of effectiveness and adequacy through conducting USMES challenges, is an indirect indication that real problem-solving _is_ subtly but pervasively structured, and that skilled USMES teachers derive satisfaction from being in control of what is taking place. Their view was borne out by classroom interaction studies (Boston University, 1973-74 _USMES Study_) which showed that USMES student comments were less often randomly or destructively directed.

USMES Materials

In general, respondents seem to have a high opinion of USMES materials (specifically USMES Unit Books). Occasional comments to the effect that there were "too few" units, and expressions of interest on the part of experienced teachers in "keeping up with" newly-produced materials underline the importance of having available materials dealing with a substantial number of different challenges at any particular school. Some respondents made note of the fact that certain challenges were "much better" than others. Activity at School B was to a great extent independent of published USMES challenges.

USMES Training and Initial Experiences for Teachers

Three general observations might be made concerning USMES training and early experience;

- It was the most experienced respondents who were most impressed by the need for taining in USMES. Thus, it would appear that one of the most significant aspects of gaining experience in USMES is becoming aware of the full scope of the program.
- Many respondents, even those regarded by our investigator as successful teachers, reported being frightened by USMES when they began to use it--USMES was "a little scary at first," teachers were "a little shaky about getting into new units," or "reluctant to let kids loose." This seems to be a general subjective phenomenon, and indicates a need, on the part of new USMES teachers, for a certain degree of emotional support.
- Most respondents who had experience with USMES national workshops felt that these workshops had been more effective as a training procedure than whatever means were locally available to potential USMES teachers on-site subsequently. They did feel, however, that local means could be used to train new teachers.

Overall Assessment of USMES

Respondents who offered an overall assessment of the USMES program were, in general, quite positive. This is of course, not surprising, since the interviewer was the project director under whom USMES was developed. One aspect of the responses offered does seem worth remarking on, however. Respondents who had done USMES for some time, and who still felt positive about the program, generally felt more positive than anyone else, and assigned to USMES a sweeping role in their overall methods of teaching--USMES was "a way of life," a teacher would "always use USMES," and many others. This does not, at first sight, appear strange. Naturally, those who continue longest in a program might likely be those who like it best. However, certain possible classes of respondents seemed to be missing, such as: the wildly enthusiastic new USMES teacher; the experienced teacher who had settled down using USMES in a continued, limited way; the respondent who didn't particularly enjoy USMES but found it worked well, and matter-of-factly intended to continue using it; etc. This is, of course, consistent with the picture projected by developers and respondents alike that USMES is a rewarding, demanding, pervasive program, capable of taking an important place in the professional life of a teacher but equiring time to achieve full mastery.

USMES AND THE "SUITABLE STUDENT"

One of the most important issues in planning an USMES implementation is simply: for what students ethnically, socially, in terms of grade level, in terms of aptitude, etc.) is USMES most effective? School Study respondents had little to say about ethnic and social variables, but did comment about grade level and scholastic aptitude.

Just as the statistical data in Part I of this study failed to show either that USMES was more successful with younger, or with older, students, so respondents interviewed were divided in this matter. USMES was reported variously to be "best for grades 3 through 6," "best for older students," "best for lower level students," "satisfactory with kindergarten students," etc. The only view which emerged consistently, and was not contradicted, seems (strangely enough) to be the particular view that first grade USMES yields less satisfactory results than that done in other grades, including kindergarten. This rather surprising generalization is consistent with the data analyzed in Part I of this study--only 9 out of 1043 sessions reported on were first grade sessions, and an unusually large proportion of these were judged "relatively unsuccessful" in terms of the reporting criteria used.

Respondents were divided on the issue of whether USMES was best for brighter, or for slower students. In general, the less privileged student populations from (Schools B and D) seemed to give teachers the impression that USMES worked best with "brighter" or "more mature" students. The school whose students were most privileged (and perhaps academically most talented), School A, seemed to convince its teachers that USMES worked best with "slower" students, or students with learning problems. This may or may not reflect in some general way the attitudes of teachers to more or less privileged populations of students.

USMES AND THE "SUITABLE SCHOOL ENVIRONMENT"

If the primary aim in producing this study has been to afford teachers, principals, and school district administrators with information for improving USMES as it is locally implemented, a secondary aim has been to gain an understanding of where USMES is likely to thrive and where (perhaps) it should not be attempted.

"Turnover" of Students and Staff

It is easiest to do good USMES if the turnover rate among staff and students is quite low. School E, an example where this is the case, shows how very good results can arise where these conditions are met. A great deal of successful USMES is done at School E with small expense, little disruption of school operation, and a great deal of mutual support among staff. This is not surprising. First, students who have become familiar with USMES through doing several challenges seem to become "good at it," and to profit more from subsequent challenges than inexperienced students. Second, learning to teach USMES takes a substantial amount of experience; if most of the teachers at a particular USMES installation are only present for a short time, then it will necessarily be true that only a small number of really skillsul USMES teachers are available at any particular time. Also, and to some extent independent of the preceding, there appears to be something like a "critical mass" effect which pertains to the continued training and support of new USMES teachers. Thus, it is extremely helpful for an inexperienced USMES teacher to be within easy ready of both practical support (a condition which is met where there are highly experienced USMES teachers) and emotional support (a condition which is met where there are relatively _many_ USMES teachers present). Third, it is not only USMES teaching _per se_, but also the "adaptation" of USMES to any particular school environment, which must be learned; this adaptation is complex because USMES is complex. Therefore even a very experienced USMES teacher coming to a new school at which USMES is used, may be for a time less effective than another teacher who is familiar with both school and program.

A stable population of students is far less critical to the successful performance of USMES than a stable group of teachers and administrators. Indeed, one of the chief reasons for the introduction of USMES at School B was to treat the alienation, discipline, and morale problems ingendered by the high turnover rate among School B students.

Stability among staff members is critical. The principal of School D, for example, was motivated by this very consideration when he used his discretionary powers to keep USMES teachers from being transferred out of his school, despite the hard feelings which might (and did) ensue. One most serious threat to the continued success of USMES at School B is that, if the principal leaves School B, the USMES implementation there may be very seriously weakened. The recently high turnover rate of teachers at School A has had a very bad effect on USMES at that school. Of course, if USMES was a commonly used school program, the effect of staff turnover would be much less serious.

Local Attitudes Towards Basic Skills Instruction

One of the most serious problems encountered by any school was the preemptive effect of very conservative attitudes, locally held, on instruction in basic skills. Particularly Schools C and A were restricted in their USMES practice by this situation. However, it was by no means clear that a vigorous local emphasis on traditional basic skills instruction posed an insuperable obstacle to the development of a strong USMES program. For example, we saw some indication that strong "back-to-basics" tendencies were present in the community containing School D. Yet, perhaps because of the diplomacy of School D's principal and perhaps because USMES at his school is an integral part of a program which also provides highly-structured teaching, School D was highly successful in having its USMES work supported.

Thus, strong local emphasis on traditional basic skills instruction seemed not to rule out successful USMES, but did create a situation in which positive action on the part of the school's principal was required.

SUMMARY

Some of the issues discussed in this section are:

- USMES and Parents. Parents at the five schools vary dramatically in:

  - attitudes towards non-graded activity
  - expectations of children
  - trust of the local school
  - desire for constant monitoring of students' progress

  Interactions between parents and programs such as USMES are complex. Fluctuations in the four variables above can "make" or "ruin" a particular USMES implementation.

- Teachers' conceptions of USMES. Most teachers' views of USMES seem fundamentally correct, but incomplete when compared with the views held by program developers. This is believed to affect USMES teaching in a number of subtle ways.

- Teachers' opinions concerning USMES. Teachers' opinions of USMES are usually quite positive. Occasionally they are negative. Virtually no respondents were "lukewarm" about USMES. There is considerable variability in teachers' opinions in the areas of basic skills, curriculum correlation, teacher training, and student autonomy. The causes of this variability are complex.

- The "suitable" USMES student. There is a great deal of disagreement concerning just what sort of student is likely to profit most from USMES. Interview reports make it clear that no simple formulation, such as "USMES is best for brighter students," "USMES is best for older students," "USMES is best for disadvantaged students," *etc.*, will suffice.

- The "suitable" school for USMES. Staff turnover and local attitudes towards basic skills instruction are particularly important factors. A high rate of staff turnover can be quite harmful, even in an otherwise satisfactory environment, unless an entire district is "saturated" with USMES. Local emphasis on basic skills *per se* is not a serious obstacle; however, a local basic skills emphasis does require positive action on the part of the school principal to justify the role of USMES in basic skills instruction.

Appendix Interview Questions

APPENDIX A: OUTLINE OF PRINCIPAL INTERVIEW

1. a) WHAT IMPACT DID YOUR USMES PROGRAM HAVE IN THE AREAS BELOW?

   b) WHAT "PROCEDURES" WERE INSTITUTED IN THESE AREAS IN ORDER TO CARRY OUT YOUR USMES PROGRAM? IN ORDER TO ALLOW OTHER PROGRAMS TO CONTINUE WITHOUT INTERFERENCE?

   c) HOW SUCCESSFUL WERE THESE PROCEDURES? WHAT WOULD YOU DO DIFFERENTLY NEXT TIME--WHAT ADVICE WOULD YOU GIVE TO OTHERS?

- SCHEDULING--providing for time that is adequate in terms of frequency, duration (team teaching; use of extra time during recess, lunch time), and flexibility (e.g., when an extra half hour is needed for USMES). Scheduling changes of other subjects.

- THE REST OF THE CURRICULUM--interaction between USMES and other subject areas; constraints by district and/or school; changes made to school or district curriculum.

- SPACE--placement of Design Lab facilities in classrooms or school; freedom of movement of kids, ability to do tasks outside school property.

- FINANCES--Design Lab supplies; written materials; additional personnel; savings on other texts and materials.

- STAFF PLANNING--choice of units affected by previous units; meetings among teachers.

- STAFF TRAINING--information/training for other teachers, aides, and student teachers. Initial team trained by USMES.

- USE OF PERSONNEL--change in roles, new assignments.

- COOPERATION--"HARMONY" (among teachers, students, principal, custodian; parents, school board, community).

- COMMUNICATIONS (for planning as well as information)--among teachers, students, principal, custodyan; parents, school board community.

- STUDENT ASSESSMENT PROCEDURES--recording student activities; reporting to parents.

- ACCOUNTABILITY PROCEDURES--reporting to principal, district administrators, school board, and community.

- OTHER AREAS

2. Describe the following factors (Interviewer: Note any relationships between the need for special procedures, or their success or failure, and these factors.)

   - DESCRIPTION OF THE SCHOOL--location, size, district organization.
   - DEMOGRAPHICS OF THE COMMUNITIES AND STUDENTS.
   - ATTITUDES--of administrators, teachers, parents, or others toward innovation, structure, or other broad aspects of school philosophy.
   - METHODS--generally used to introduce new curricula into the school.
   - WHY SCHOOL BECAME INVOLVED IN USMES--history of involvement, motivation of teachers and administrators.
   - TYPE OF USMES TRAINING--received by the teachers and administrators. Ronnie was at Hardy School R.T.W. (see page 4, Staff Training)
   - HOW USMES IS IMPLEMENTED IN THE SCHOOL--Design Lab facilities, units taught, grade levels, time periods, number of USMES teachers, USMES materials available, support from administrators and parents.
   - PLACE OF USMES IN CURRICULUM--as science, interdisciplinary, supplementary, or core program. What do you want students to gain from their USMES experience? Which of these areas are most important to you?
   - OTHER FACTORS.

GENERAL QUESTIONS

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3. What seems to be the effect of USMES on the school in general?

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4. What seems to be the effect of USMES on the students in general?

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5. What is the future of USMES at your school?

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6. How would USMES have to be different to make it fit better into your school program? What is your personal opinion of USMES at your school?

APPENDIX B: OUTLINE OF TEACHER INTERVIEW

1. Type of classroom. Self-contained? Some kids all the time? Individual or self-paced work?
2. What programs do you use in math, language arts, etc.--before and after USMES?
3. Scheduling before and after USMES.
4. Do you have enough time? The right choice of time (flexibility)?
5. Did you keep any record of kids or class problem-solving experience?
6. Grading and parent report forms.
7. Reporting to principal or district--accountability.
8. Parent involvement.
9. Staff meetings? Correlation of each class USMES program. Management system.
10. USMES correlated with district or school goals or objectives publicly. Constraints from school, district, or state.
11. How is Design Lab run? How does it work?
12. National tests--check USMES kids?
13. Relations between USMES teachers and non-USMES, principal, custodian, community.
14. Personal opinion of USMES. Does your USMES differ from mainstream USMES?
15. If you stopped, why?
16. Recommendations--